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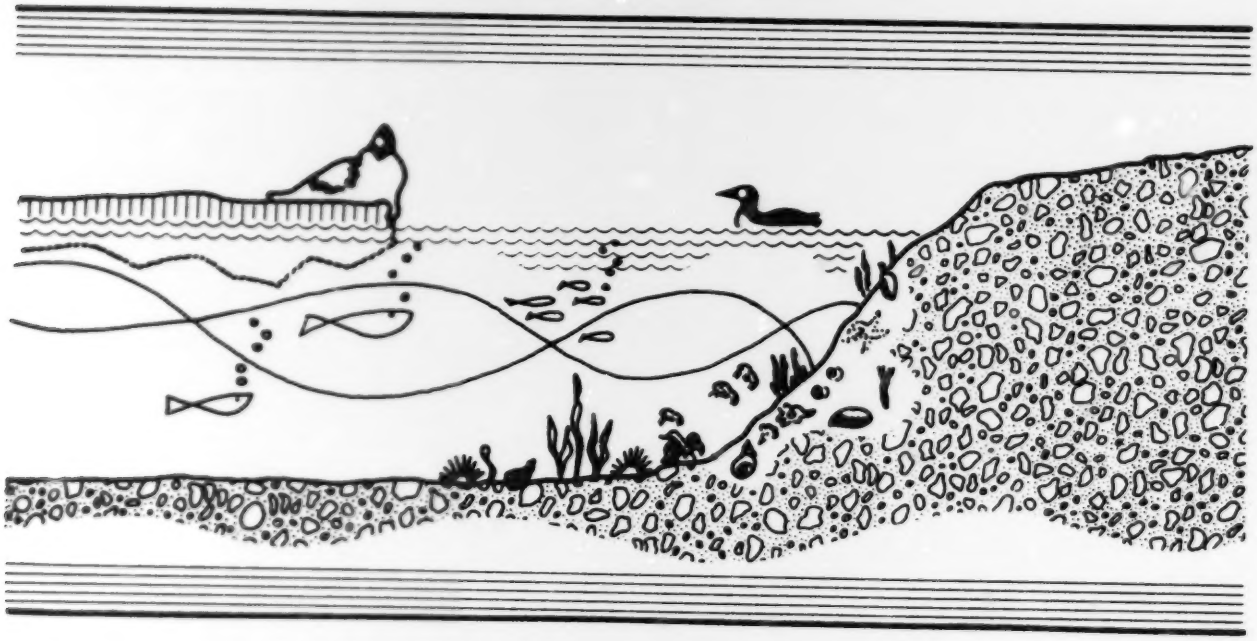

Baffin Island Oil Spill Project

WORKING REPORT SERIES

1982 STUDY RESULTS

The Baffin Island Oil Spill Project

OBJECTIVES

The Baffin Island Oil Spill (BIOS) Project is a program of research into arctic marine oil spill countermeasures. It consists of two main experiments or studies. The first of these, referred to as the Nearshore Study, was designed to determine if the use of dispersants in the nearshore environment would decrease or increase the impact of spilled oil. The second of the two experiments in the BIOS Project is referred to as the Shoreline Study. It was designed to determine the relative effectiveness of shoreline cleanup countermeasures on arctic beaches.

The project was designed to be four years in length and commenced in 1980.

FUNDING

The BIOS Project is funded and supported by the Canadian Government (Environment Canada: Canadian Coast Guard; Indian and Northern Affairs; Energy, Mines & Resources; and Fisheries & Oceans), by the U.S. Government (Outer Continental Shelf Environmental Assessment Program and U.S. Coast Guard), by the Norwegian Government and by the Petroleum Industry (Canadian Offshore Oil Spill Research Association; BP International [London] and Petro-Canada).

WORKING REPORT SERIES

This report is the result of work performed under the Baffin Island Oil Spill Project. It is undergoing a limited distribution prior to Project completion in order to transfer the information to people working in related research. The report has not undergone rigorous technical review by the BIOS management or technical committees and does not necessarily reflect the views or policies of these groups.

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BAFFIN ISLAND OIL SPILL PROJECT
CHEMISTRY COMPONENT

REPORT ON THE 1982
OIL SPILL EXPERIMENTS

VOLUME 1
SUMMARY OF FIELD WORK
AND
SHORELINE HYDROCARBON ANALYSIS

Final Report
Contract No. OSS82-00058

Prepared for

Environment Canada
Environmental Protection Service
Edmonton, Alberta

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MAY 1983

ABSTRACT

The sampling for the Baffin Island Oil Spill Chemistry component is described. The analytical method for total hydrocarbons and the results of those analyses are presented. Samples taken in 1982 are listed with the results of corresponding analyses from 1980 and 1981.

ACKNOWLEDGEMENTS

I wish to thank David Hope for his support in the field and for his excellent analytical work. I would also thank Dr. David R. Green for his advice during the preparations and completion of this project.

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TABLE OF CONTENTS

ABSTRACT	i
FOREWARD	ii
ACKNOWLEDGEMENTS	iii
TABLE OF CONTENTS	iv
LIST OF TABLES	v
LIST OF FIGURES	vi
1. INTRODUCTION	1
2. SAMPLING STRATEGIES	2
2.1 SHORELINE COUNTERMEASURES	2
2.2 RAGGED CHANNEL SHORELINES	10
2.3 SEAWATER SAMPLES	13
2.4 LARGE VOLUME WATER SAMPLES	16
2.5 BOTTOM SEDIMENTS	18
2.6 FLOC SAMPLES	20
2.7 SEDIMENT TRAPS	22
2.8 CORES	22
2.9 TISSUE SAMPLES	23
3. ANALYTICAL METHOD	24
3.1 EXTRACTION PROCEDURE	24
3.2 ANALYSIS	25
4. RESULTS	26
4.1 SHORELINE TOTAL HYDROCARBON ANALYSIS	26
4.2 RAGGED CHANNEL BEACHES	46
5. DISCUSSION	48
6. REFERENCES	49
7. APPENDIX	50

LIST OF TABLES

Table 1: High energy shoreline; aged crude Plot H1 27
Table 2: High energy shoreline; emulsion Plot H2 28
Table 3: Low energy shoreline; aged crude Plot L1 29
Table 4: Low energy shoreline; emulsion Plot L2 30
Table 5: Backshore control; aged crude Plot T1 31
Table 6: Backshore control; emulsion Plot T2 31
Table 7: Microbiology control; aged crude Plot TE1 32
Table 8: Microbiology control; emulsion Plot TE2 32
Table 9: 1981 Control; aged crude Plot CC 33
Table 10: 1981 Control; emulsion Plot CE 33
Table 11: 1981 Mixing; aged crude Plot MC 33
Table 12: 1981 Mixing; emulsion Plot ME 33
Table 13: 1981 Exxon dispersant; aged crude Plot D[E]C 34
Table 14: 1981 Exxon dispersant; emulsion Plot D[E]E 34
Table 15: 1981 BP dispersant; aged crude Plot D[B]C 35
Table 16: 1981 BP dispersant; emulsion Plot D[B]E 35
Table 17: 1982 Z-Lagoon Baseline 36
Table 18: 1982 Control; aged crude Plot ICC 37
Table 19: 1982 Control; emulsion Plot ICE-East 38
Table 20: 1982 Control; emulsion Plot ICE-West 39
Table 21: 1982 Exxon dispersant; aged crude Plot ID[E]C 40
Table 22: 1982 Exxon dispersant; emulsion Plot ID[E]E 41
Table 23: 1982 BP dispersant; aged crude Plot ID[B]C 42
Table 24: 1982 BP dispersant; emulsion Plot ID[B]E 43
Table 25: 1982 Backshore; aged crude Plot IMC 44
Table 26: 1982 Backshore; emulsion Plot IME 45
Table 27: Surface oil release, Bay 11 Shoreline 46
Table 28: Dispersed oil release, Bay 9 Shoreline 47
Table 29: Seawater Samples 51
Table 30: Large Volume Water Samples 53
Table 31: Tissue Plot Sediments 55
Table 32: Benthic Plot Sediments 56
Table 33: Floc Samples 57
Table 34: Sediment Traps 58
Table 35: Tissue Samples 60

LIST OF FIGURES

FIGURE 2.1: Cape Hatt 4

FIGURE 2.2: Z - Lagoon 5

FIGURE 2.3: 1980 Plots 6

FIGURE 2.4: 1981 Plots 7

FIGURE 2.5: 1982 Intertidal Plots 8

FIGURE 2.6: 1982 Backshore Plots 9

FIGURE 2.7: Bay 11 11

FIGURE 2.8: Bay 9 12

FIGURE 2.9: Dispersed Oil Release 15

FIGURE 2.10: Large Volume Water Sampler 17

FIGURE 2.11: Bottom Sediment Plots 19

FIGURE 12: 2.12: Floc Sampler 21

1. INTRODUCTION

Seakem's participation in the third year of the Baffin Island Oil Spill Project (BIOS) consisted of two components: the collection of samples in the field for various purposes and the analysis of the shoreline sediments for total hydrocarbon content.

Two people from Seakem were in the field from August 10,1982 to early September . During that time, the following groups of samples were collected:

Shoreline sediments for total hydrocarbon
Shoreline sediments for gas chromatography
Seawater samples
Large volume water samples
Tissue plot sediments
Benthic plot sediments
Floc
Sediment trap contents
Sediment cores

Assistance was given in the collection of the following animals:

Astarte borealis
Mya truncata
Macoma calcarea
Serripes groenlandia
Strongylocentrotus droebrachiensis

While in the field, a start was made on the analysis of the shoreline sediments for total hydrocarbon content. These analyses were finished in the laboratory after the end of the field season.

This report describes the sampling strategy for 1982. It describes the analytical method for total hydrocarbon content, and provides the results of those analyses. An appendix includes sample lists and historical results for hydrocarbon analyses of those groups of samples collected in the third year.

2. SAMPLING STRATEGIES

The site of the BIOS experiments at Cape Hatt at the north end of Baffin Island (Figure 2.1) is divided into areas for the two major experiments which are in progress. Around Z Lagoon on the east side of the cape, various shoreline countermeasures experiments have taken place. On the west side, along the shores of Ragged Channel, two experimental oil releases were made in 1981. In Bay 11, about 15,000L of Lago medio crude oil were released gently onto the surface inside a boom enclosing the beach area, about half of which stranded on the beach. In Bay 9, the same amount of oil was mixed 10:1 with a dispersant, Corexit 9527, and released at depth through a diffuser into the water column (Dickins, 1982).

The sampling strategies for the 1982 sampling period were based on the sampling done in previous years, in particular 1981.

All samples were logged immediately upon collection. The log sheet included dates for the completion of each step of the analyses, and a signature when the samples were passed to a different laboratory.

2.1 SHORELINE COUNTERMEASURES

In 1980, a number of plots were set out to provide control data for experiments in 1981 and 1982. These plots are:

H1	High energy shoreline, aged crude
H2	High energy shoreline, emulsion
L1	Low energy shoreline, aged crude
L2	Low energy shoreline, emulsion
T1	Backshore control, aged oil
T2	Backshore control, emulsion
TE1	Microbiology control, aged oil
TE2	Microbiology control, emulsion

In 1981, a number of plots were set out to test the efficiency of various shoreline countermeasures:

CC	Control, aged crude
CE	Control, emulsion
MC	Mixing, aged crude
ME	Mixing, emulsion
D[E]C	Exxon dispersant, aged crude
D[E]E	Exxon dispersant, emulsion
D[B]C	BP dispersant, aged crude

D[B]E	BP dispersant, emulsion
SC	Solidifier, aged crude
SE	Solidifier, emulsion

In 1982, a number of plots were set out in a low energy intertidal area to test the efficiency of countermeasures in that regime:

ICC	Control, aged crude
ICE-E	Control, emulsion
ICE-W	Control, emulsion
ID[E]C	Exxon dispersant, aged crude
ID[E]E	Exxon dispersant, emulsion
ID[B]C	BP dispersant, aged crude
ID[B]E	BP dispersant, emulsion
IMC	Backshore, aged crude
IME	Backshore, emulsion
NCC	Norwegian control, crude
NCF	Norwegian fertilized, crude
NEC	Norwegian control, emulsion
NEF	Norwegian fertilized, emulsion

Samples were taken at three levels on nine transects in Z-Lagoon prior to the 1982 experiments to provide baseline data before the site was chosen. These samples were analysed at Cape Hatt.

With the exception of the solidifier plots from 1981, all of the plots have been sampled in 1982. The presence of solidifier interfered with the analysis of the sediments in 1981, so no attempt was made to analyse them in 1982. As in previous years, both surface and subsurface samples were taken for total hydrocarbon content. Subsurface samples were obtained by carefully removing the surface down to 5 cm, then sampling down to 10 cm. Samples for gas chromatography were taken from the surface only. Samples were composites of a number of scoops of sediment taken from predetermined sites in the plots. The locations of the plots are shown in Figure 2.2. The sampling sites for each group of plots are shown in Figures 2.3 to 2.6. The samples for TE1 and TE2 were taken from the edge of the exposed plot. Samples for total hydrocarbon analysis were collected in Whirlpak bags and frozen until extraction.. Samples for gas chromatographic analysis were collected in baked 8 oz glass jars, covered with a Teflon liner, and stored frozen until analysis.

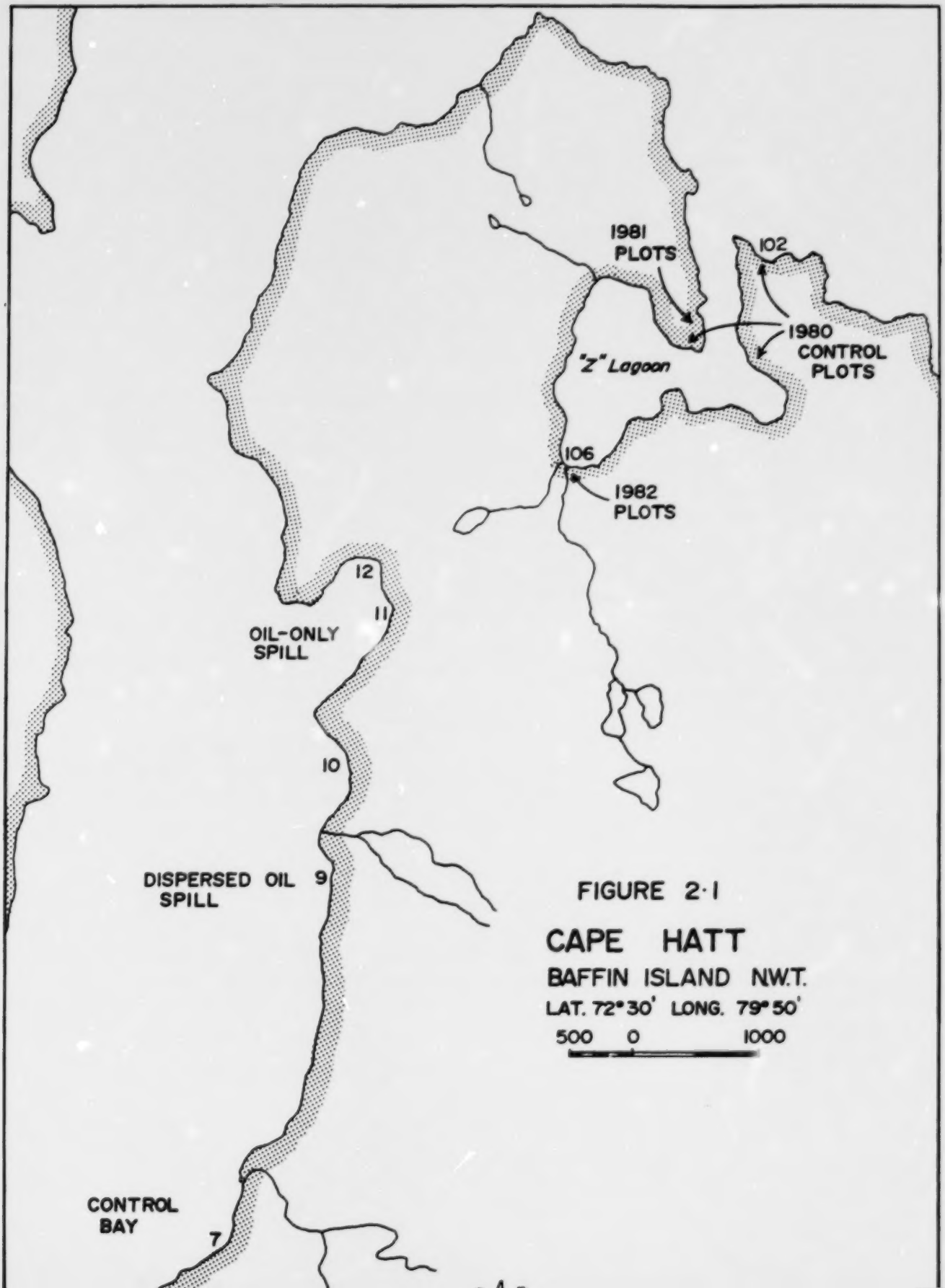

FIGURE 2·1

CAPE HATT

BAFFIN ISLAND N.W.T.

LAT. 72° 30' LONG. 79° 50'

500 0 1000

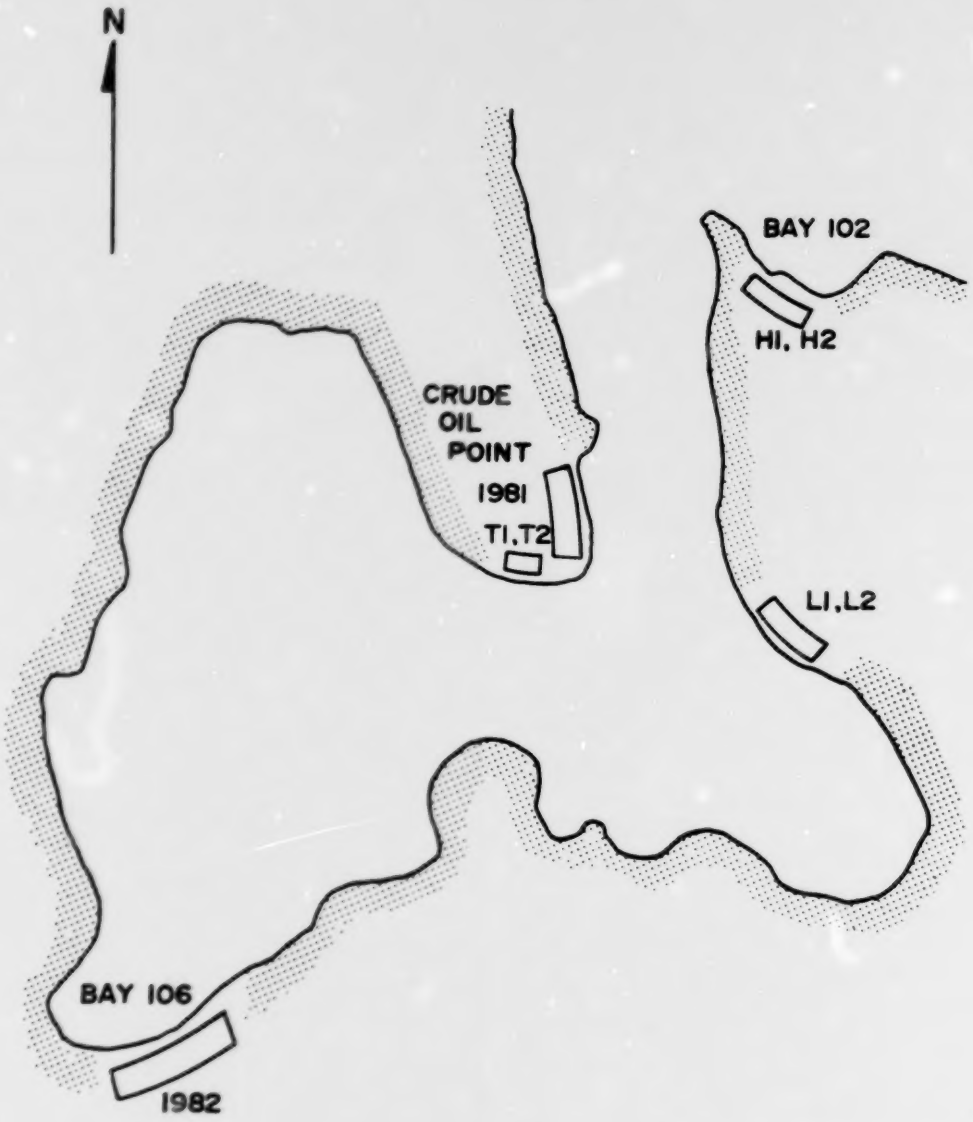

FIGURE 2·2 Z – LAGOON

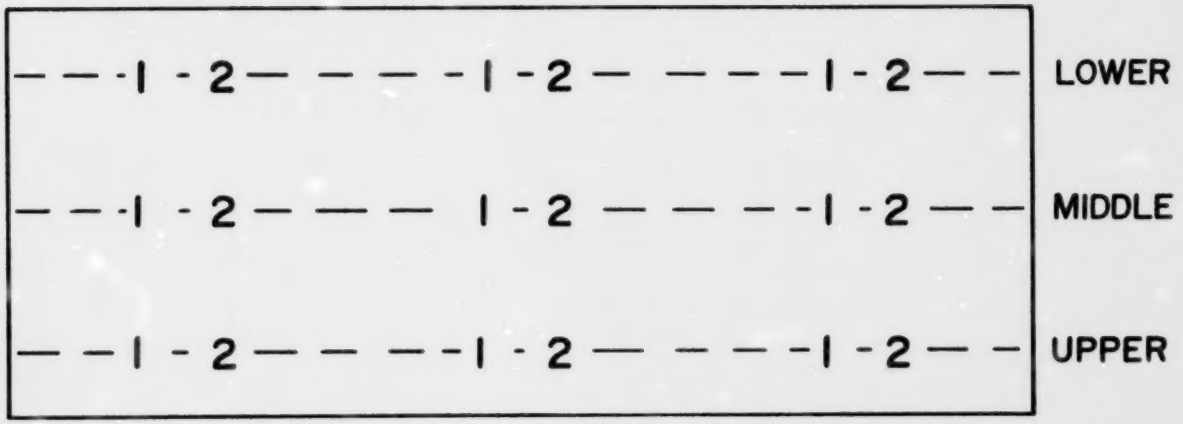

FIGURE 2-3

1980 CONTROL PLOTS H1, H2, L1, L2.

1. SAMPLED 82:08:10
2. SAMPLED 82:09:02

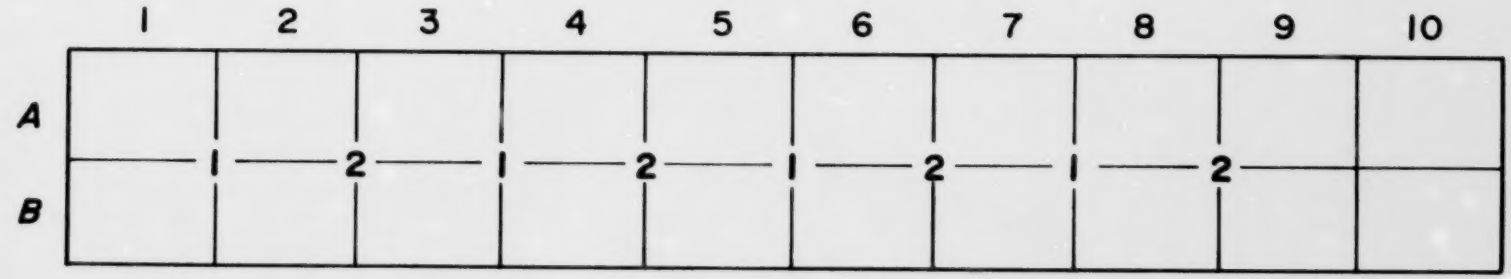

FIGURE 2·4

1981 PLOTS T1, T2.

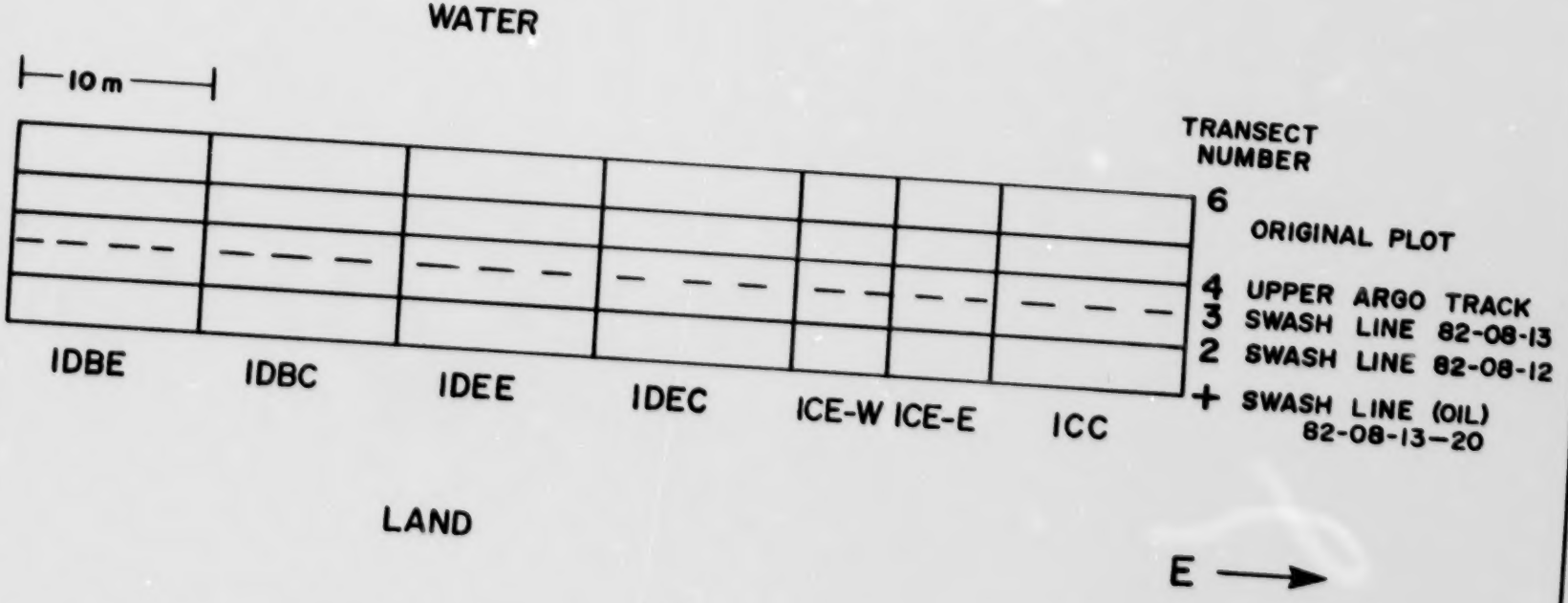

FIGURE 2·5

1982 INTERTIDAL PLOTS

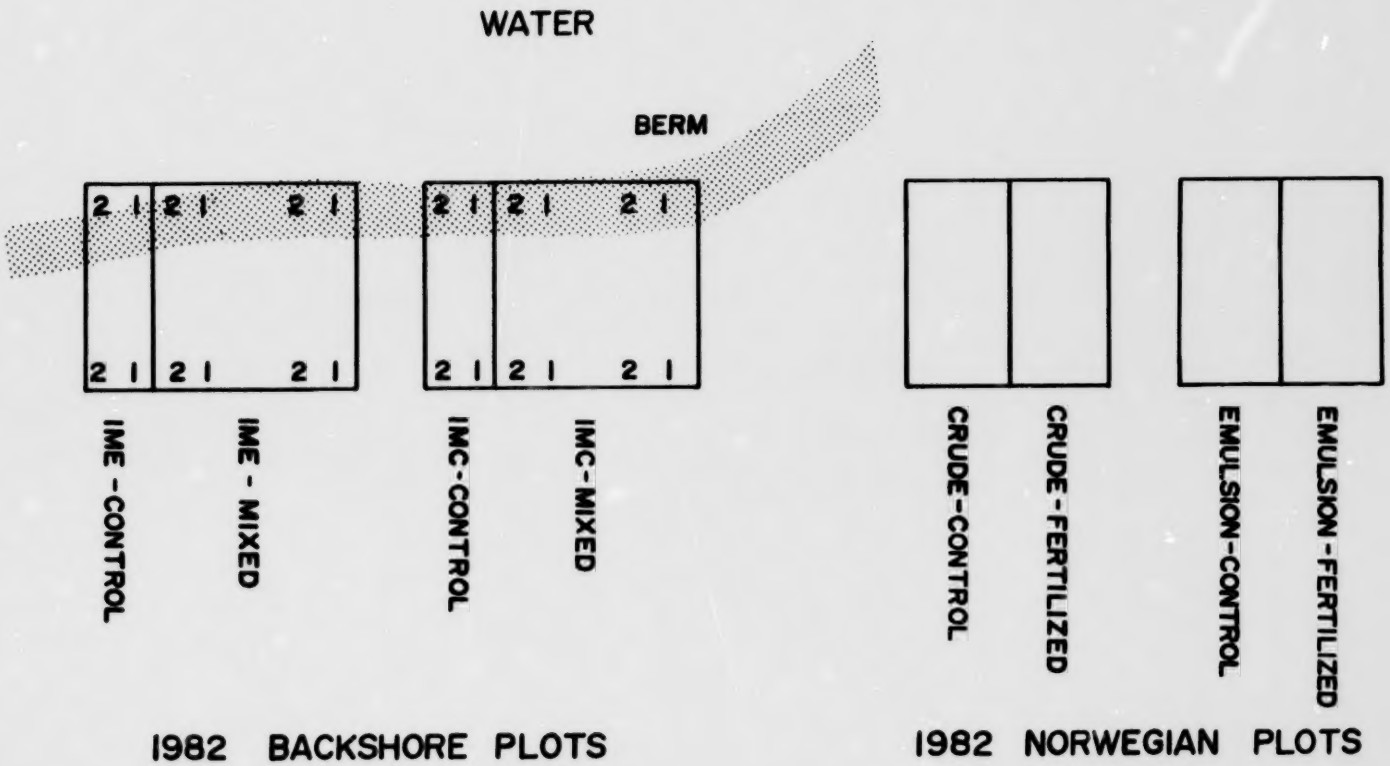
WATER
BERM
2 1
IME - CONTROL
IME - MIXED
IMC - CONTROL
IMC - MIXED
1982 BACKSHORE PLOTS
CRUDE - CONTROL
CRUDE - FERTILIZED
EMULSION - CONTROL
EMULSION - FERTILIZED
1982 NORWEGIAN PLOTS

FIGURE 2·6

2.2 RAGGED CHANNEL SHORELINES

2.2.1 Bay 11, Surface oil release

In 1981, on three occasions after the oil release on August 19, the beach in Bay 11 was sampled for hydrocarbon content. The beach was sampled at three levels relative to the tide. The upper level was just below the high tide mark, the lower level at the low tide line at that time, and the middle level was half way between the two. The samples were obtained from three transects down the beach. Figure 2.7 identifies these sites. In 1982, these sites were resampled on one occasion. Samples were taken from the surface and from the 5-10 cm subsurface layer. The samples were analysed separately. Additional surface samples were obtained for gas chromatographic analysis.

2.2.2 Bay 9, Dispersed oil release

On August 27,1981, oil was released as a dispersion into the water column in Bay 9. No obvious stranding occurred, but the beach was sampled in the same manner as the Bay 11 beach. Figure 2.8 identifies the sites. The beach was resampled on one occasion in 1982.

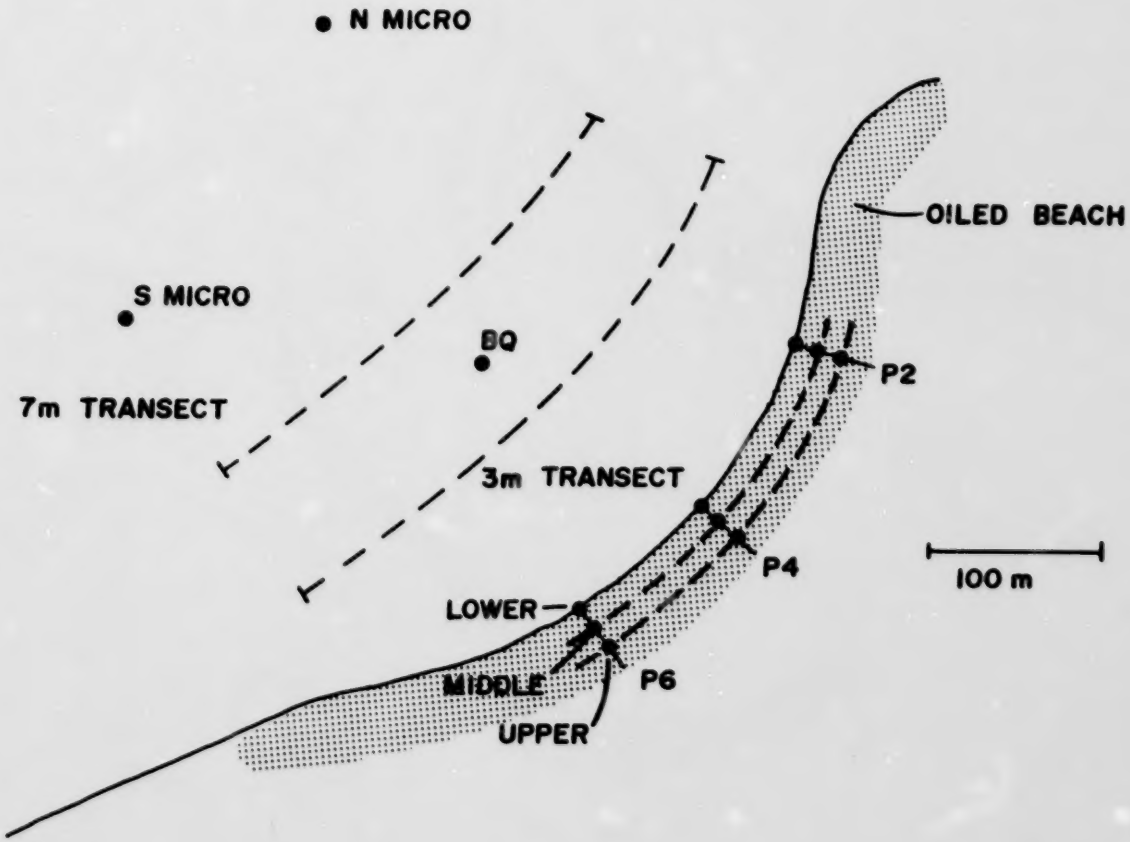

FIGURE 2·7
BAY 11

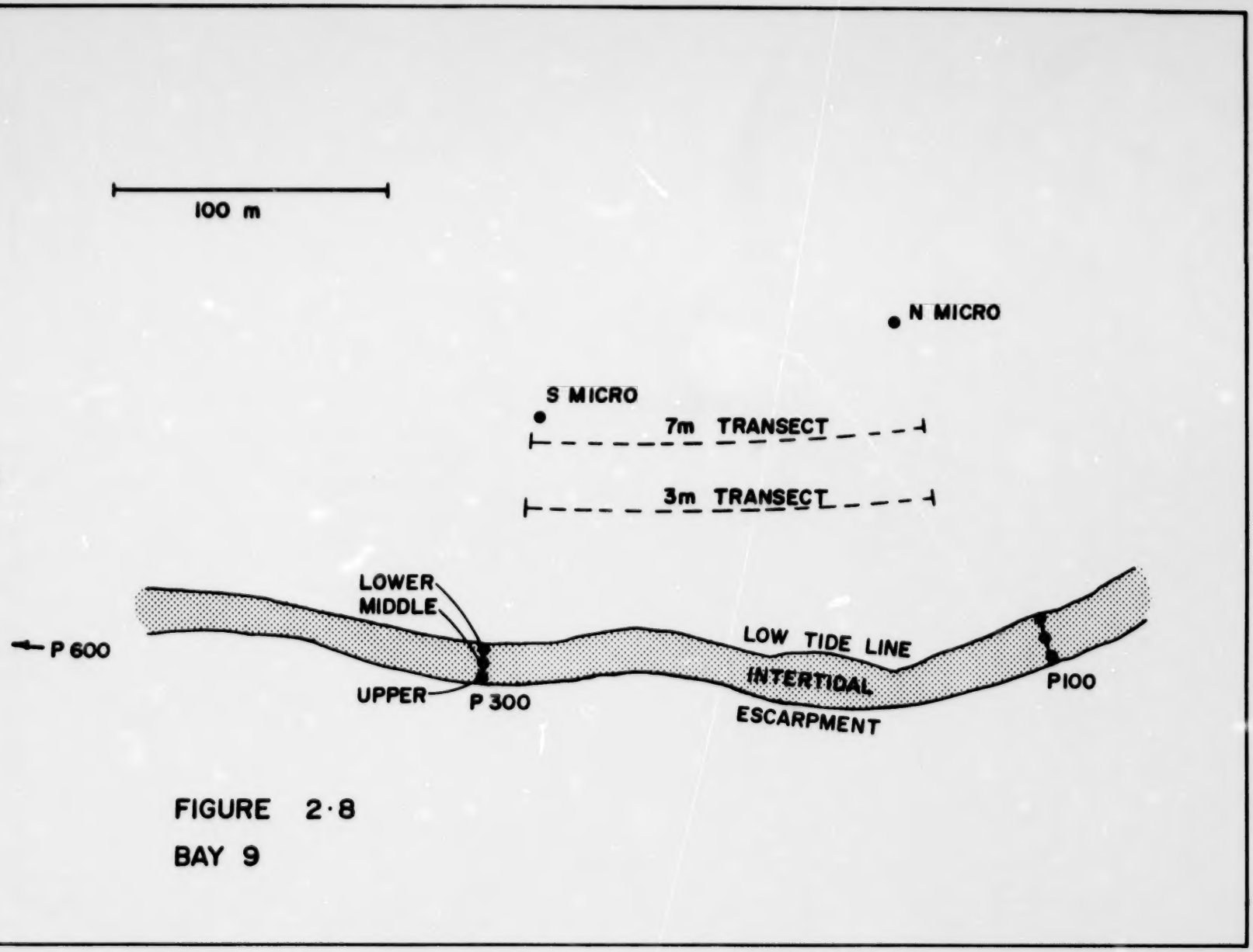

FIGURE 2·8

BAY 9

2.3 SEAWATER SAMPLES

Seawater samples were collected in 4 L glass jugs which had been baked clean before being sent to Cape Hatt. The water sample was extracted three times with 40 mL glass-distilled Freon 113. The extract was evaporated to about 20 mL, dried, and stored in a freezer until analysis. If a jug was reused, it was dried with clean acetone then rinsed twice with glass-distilled Freon 113.

2.3.1 Bay 11, Surface oil release

During and after the surface oil release in 1981, samples of seawater were collected to identify the movement of oil into the water column. During the release, continuous pumped fluorometery monitored three depths in the experimental area. After the release, water was sampled at various depths for three weeks. In 1982, samples were collected at some of the same stations as the previous year. Other samples were obtained at the same time and depth as large volume water samples for correlation. These samples were taken from the outlet of the LVWS pump system, after the sampler itself had been removed. A sample was taken in the intertidal area, as the tide was dropping. Three samples of visible surface sheen were collected.

2.3.2 Bay 10, Dispersed oil release

During the dispersed oil release in Bay 9, a number of samples were taken at sites in Bay 10 to monitor any oil entering that bay. Significant levels were found during the release and for some days after. In 1982, some water samples were taken as part of the microbiology studies. Figure 2.9 identifies the sampling sites for both years.

2.3.3 Bay 9, Dispersed oil release

During the release, continuous pumping fluorometry monitored the oil in the water column. Twenty samples were collected at the same time for chromatographic analysis and 96 for instrument validation. A number were also collected as part of the microbiology studies. In 1982, samples were again collected as part of the microbiology studies. Figure 2.9 identifies the sites.

2.3.4 Bay 7, Control

It became apparent from the physical oceanographic measurements made in 1980 and 1981 that both Bays 9 and 10 would be impacted by dispersed oil, so Bay 7 to the south was selected as an alternative control bay. Samples were taken in 1981 as part of the microbiology studies. In 1982, this was repeated.

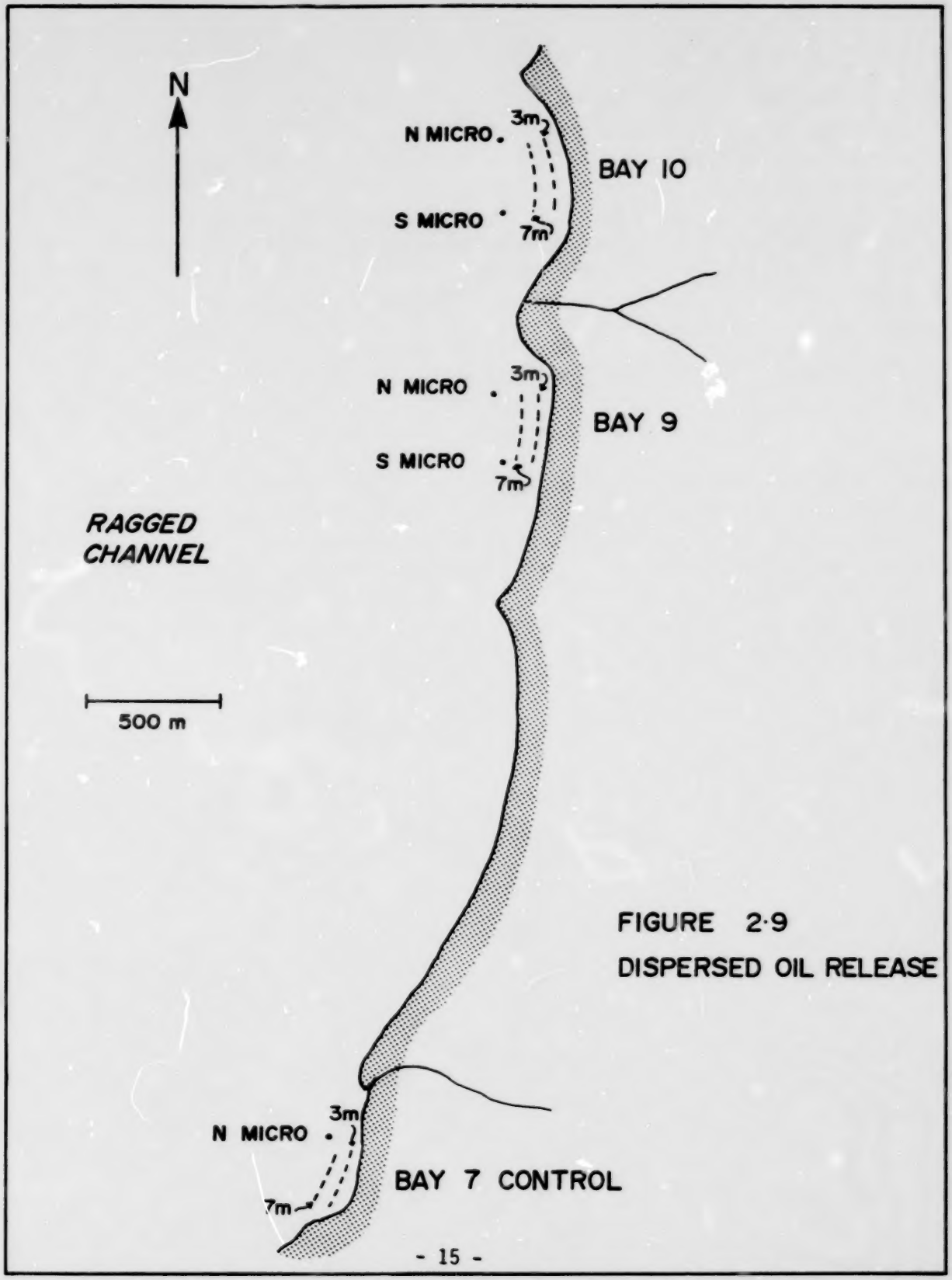

FIGURE 2·9
DISPERSED OIL RELEASE

2.4 LARGE VOLUME WATER SAMPLES

In 1980, a novel sampling system described by de Lappe and Risebrough (de Lappe et al, 1979) was used to collect samples for very low levels of hydrocarbons in sea water. In 1981 and 1982 this sampler was modified slightly to make it more easily handled and more consistent. In 1980 and 1981, the volumes passed through the sampler were not consistently measured because of the possibility of leaks at the sampler, which was under water and thus out of view. In 1982 the sampler was modified to have the sampler in view so that leaks could be checked. The sampler as it was used in 1982 appears in Figure 2.10.

Samples were taken at 10 m and near the bottom in Bays 7,9,10 and 11 in 1982. In Bay 11, additional samples were taken near the surface and in the beach intertidal area, on a rising and a falling tide.

The samples consist of a glass fiber filter paper (Whatman GF/C) containing particulate matter and a tube packed with 12 polyurethane foam plugs containing dissolved organic matter. These plugs, about 2.5 x 5 cm each, were cut from polyurethane foam and cleaned by continuous extraction with a 1:1 acetone:hexane mixture for 72 hours, the solvent being changed every 24 hours. Both filters and columns were wrapped in baked aluminum foil and frozen until analysis.

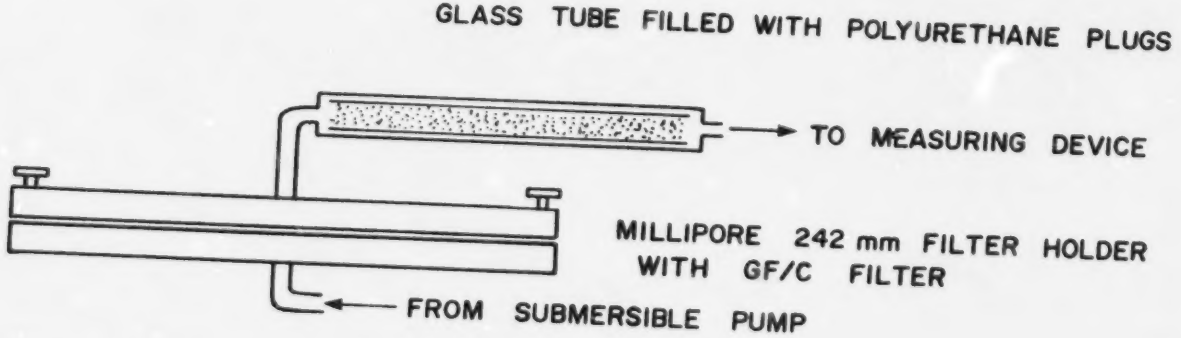
GLASS TUBE FILLED WITH POLYURETHANE PLUGS
TO MEASURING DEVICE
MILLIPORE 242 mm FILTER HOLDER
WITH GF/C FILTER
FROM SUBMERSIBLE PUMP

FIGURE 2·10
LARGE VOLUME WATER SAMPLER

2.5 BOTTOM SEDIMENTS

Bottom sediments have been taken in all three years of the project. In 1981, the experimental areas were layed out in a consistent pattern in all four bays. Figure 2.11 outlines the pattern for plots in a bay.

The samples were collected in 8 oz wide mouth jars by divers. The jars were sent to the bottom closed, in a jar holder. The diver removed the lid, used the jar to scrape sediment from the 0-2 cm layer into the jar, closed it, and returned it to the surface. A Teflon liner was placed under the lid and the sample frozen until analysis.

2.5.1 Tissue plot sediments

In 1981, before and after the experimental spills, the tissue plots were sampled for hydrocarbons in the sediments. Each plot was sampled once before the release and twice after, close to the times the animals were being taken from the same plots. In 1982, samples were taken in the five tissue plots at the 7 m depth only in each bay. The number of samples taken in each plot is marked in the corresponding box in Figure 2.11. Where more than one sample was collected in a plot, all were taken from the same location and no distinction was made between samples.

2.5.2 Benthic plot sediments

In 1981, additional samples were taken from the benthic plots in each bay late in the season. In 1982, this was repeated at all benthic plots in each bay. The number of samples from each plot is indicated in Figure 2.11. The samples were taken at predetermined random distances along the benthic transect, but the samples were not identified as to location within each plot.

2.5.3 Microbiology station sediments

For the three years of the project, samples have been taken from the microbiology stations.

2.5.4 Deep sediments

In 1982, four samples of sediment from 15 m depth were collected in Bays 9 and 11.

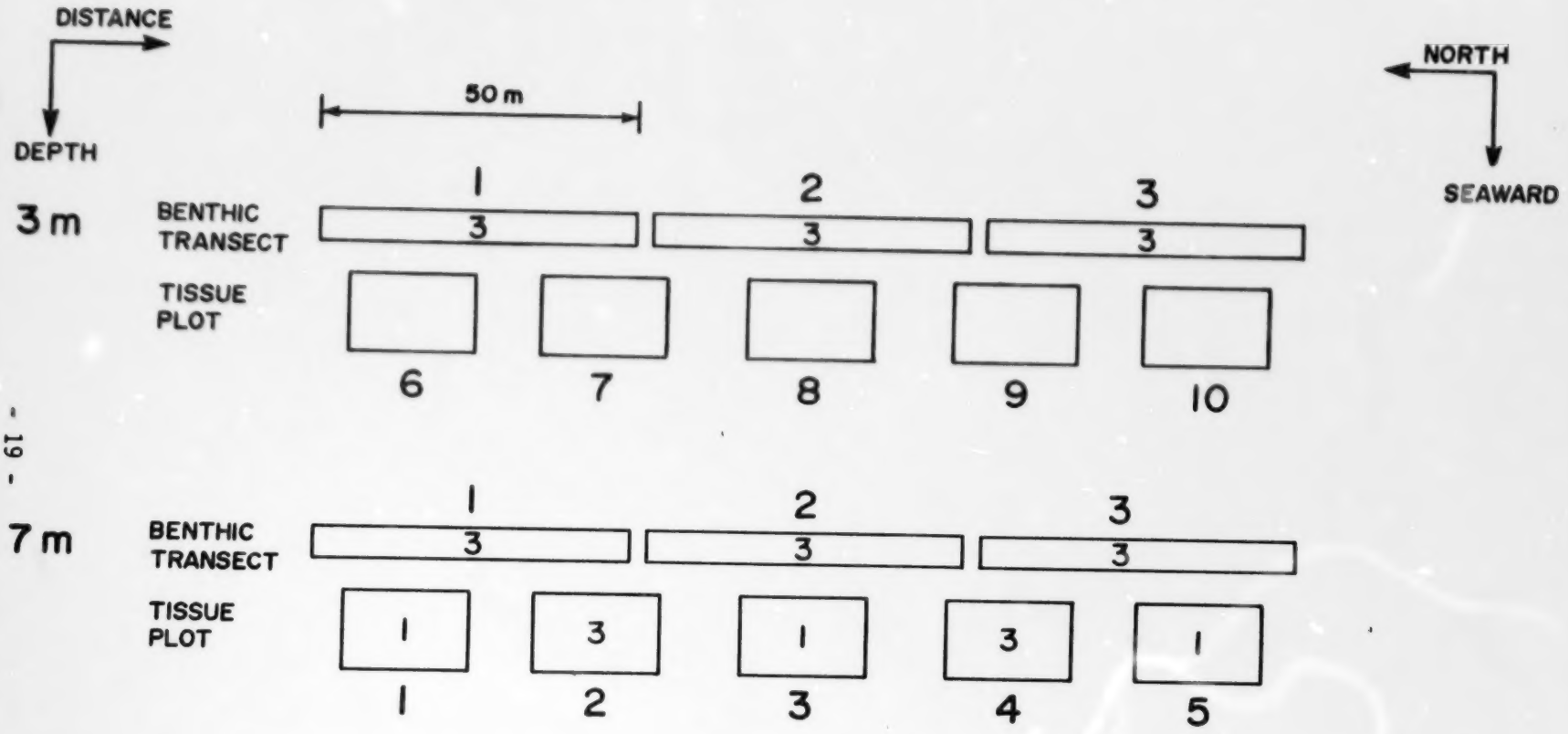

FIGURE 2·11

BOTTOM SEDIMENT PLOTS

2.6 FLOC SAMPLES

The very light, newly settled layer of sediment is of particular interest in this project. Called "floc", this material may contain the bulk of the oiled material entering the sediments from the water column. In order to sample this material, an underwater filtering apparatus was developed (Figure 2.12). This device was operated by divers. It was sent down to the diver with a fresh glass fiber filter in the bypass position. When the diver was in place, he directed the pumped water through the filter and sucked up the loose surface material in a 1 m^2 area in the tissue plot as identified in Figure 2.11. The filter was then bypassed and the sampler returned to the surface. The filter was wrapped in baked aluminum foil and frozen until analysis.

In 1981, samples were taken from all tissue plots in all four bays. In 1982, samples were taken from all tissue plots in Bay 11 only.

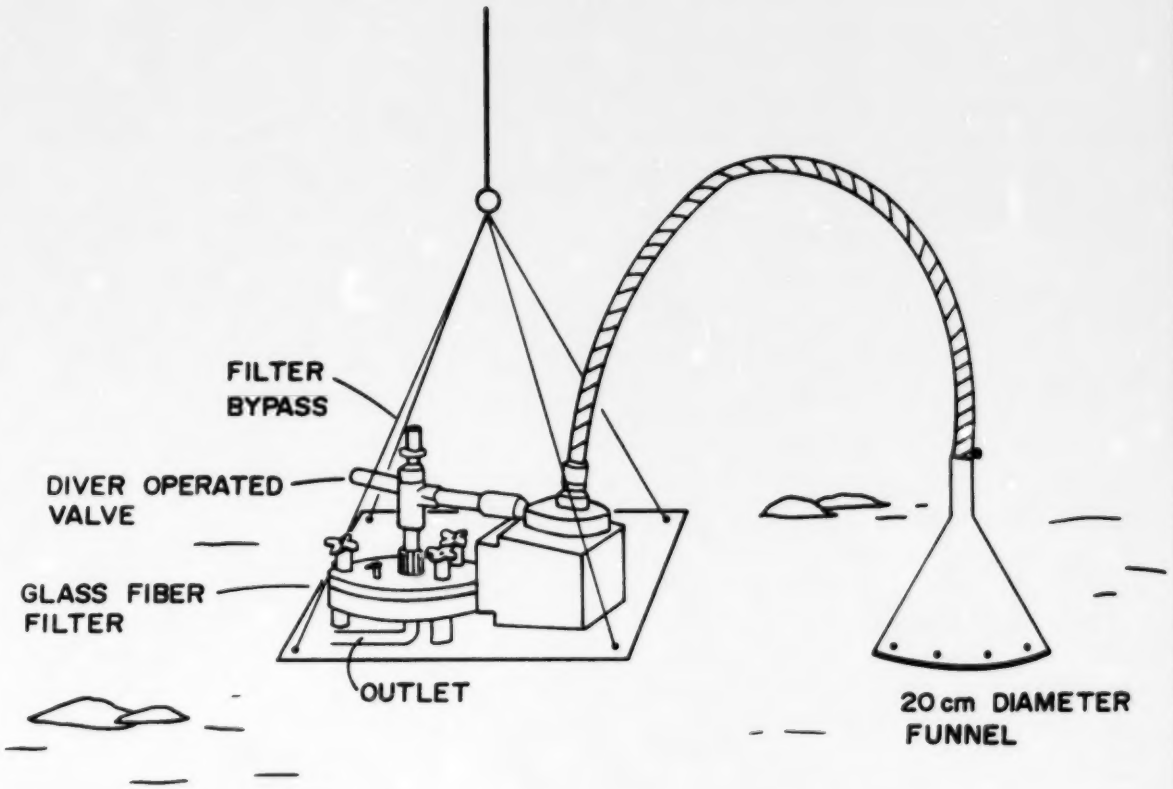

FIGURE 2·12

FLOC SAMPLER

2.7 SEDIMENT TRAPS

Sediment traps may be used to collect the same type of material as the floc sampler. Left for a long period of time in an undisturbed area, any large particles in the water column may settle into the trap. No poisoning agent was added to the traps. After the collection period, the traps were carefully returned to the surface by divers. The collecting beaker was removed, the bulk of the water decanted, and the settled material transfered to a baked jar. A Teflon liner was placed under the lid and the sample frozen until analysis.

Twenty-three samples were collected in 1981. At the end of the season in 1981, traps were left in all four bays to overwinter. This was an ad-hoc addition to the sampling scheme, as no other long collecting periods have been done. In 1982 they were recovered and redeployed in Bay 11 for two periods.

2.8 CORES

Sediment cores were collected in 1982. Using hand corers, divers obtained cores at each end of the 7 m transect in all four bays. Each sample was frozen in the sampler immediately after collection. Samplers were warmed to facilitate removal of the core, the core was cut into sections of 5 cm lengths, placed in baked 8 oz jars, which were sealed with Teflon and kept frozen until analysis.

The nature of the samplers and the sediments precluded obtaining complete samples from all bays. The samples collected were:

Date	Bay	0-5 cm	5-10 cm	10-15 cm
82-08-18	7N	x	NS	NS
82-08-18	7S	x	x	NS
82-08-17	9N	x	x	NS
82-08-17	9S	x	x	NS
82-08-16	10N	x	x	NS
82-08-16	10S	x	x	NS
82-08-15	11N	x	x	x
82-08-15	11S	x	x	NS

[NS = no sample]

2.9 TISSUE SAMPLES

Over the three years of the project, many animals have been collected for hydrocarbon content analysis. In 1980, seven animal and three plant species were collected. In 1981, six animal species were collected, of which three had been collected in 1980. In 1982, five animal species were collected, all of which had been collected in 1981, and three of which had been collected in 1980.

The animals were collected by divers. Astarte and Strongylocentrotus were hand picked at all times, all the others were usually sampled using an airlift technique, although Serripes was hand picked if found on the surface. The samples were taken from anywhere within the 7 m tissue plots in each bay (Figure 2.11). When the samples were brought ashore, they were sorted according to species. Ten animals of each species from each plot were wrapped in aluminum foil and frozen until analysis.

The species collected in 1982 were:

Astarte borealis
Mya truncata
Macoma calcarea
Serripes groenlandia
Strongylocentrotus droebrachiensis

With the exception of Bay 11, adequate numbers of samples were found. Bay 11 did not provide enough Serripes.

3. ANALYTICAL METHOD

Shoreline sediments have been analysed for total hydrocarbon in all three years of the project. The method of analysis has changed each year to reflect the changing program.

In 1980, much of the analysis was to determine baseline levels of hydrocarbon in the beach sediments. In conseguence, a precise but time-consuming method was used. The detection limit for this method was 0.25 mg/kg (Green 1981).

In 1981, in response to the need for the analysis of large numbers of samples to reduce the problem of sampling a large plot, subsamples were taken in a number of sites within a plot. Some sites were composited before extraction, and composited again after extraction with samples from other sites in the same plot. Over three hundred samples were analysed in 1981 (Green et al, 1982).

Carbon tetrachloride was used as solvent in 1981, as it is the most effective solvent available for the determination of oils by IR. The ventilation conditions in the laboratory at Cape Hatt were found to be inadequate for using a toxic solvent of this nature.

In 1982, the solvent was changed to the less toxic Freon 113, for safety reasons. The procedure remained the same, with the exception that the amount of extract used for ultimate analysis depended on the visual appearance of the extract.

3.1 EXTRACTION PROCEDURE

Between 0.5 and 2.0 kg of beach sediment were placed in a Teflon extraction jug with a Teflon lid. About 0.2 kg of Freon 113 was added and the sample shaken on a paint shaker for 5 minutes. If the extract showed visible oil content, a 4 mL aliquot was transfered to a small break-neck ampoule which was then sealed in a flame. If there was no visible oil in the extract, two 20 mL aliquots were transfered to two large break-neck ampoules. The weight of each aliquot was recorded.

When very highly oiled samples were extracted, some dark precipitate remained in the extraction jug. This was not the case when CCl_4 was used. This material was soluble in CCl_4. A solution of this material in CCl_4, which

was opaque to visible light, was analysed in the same manner as the extracts. No CH_2 absorption at 2850 cm^{-1} was observed. As the analytical method is based on this CH_2 absorption it was felt that the change to Freon 113 would not bias the results relative to the CCl_4 extraction method.

3.2 ANALYSIS

The analysis of oil by Infra-red absorption is based on the CH_2 absorption at 2850 cm^{-1}. A calibration curve based on the absorption of Lago medio standard solutions was used to determine the concentration of the sample.

Sample extracts that were visibly very concentrated were diluted gravimetrically before analysis. Samples that were visibly dilute were concentrated by gentle evaporation with a stream of dry nitrogen before analysis.

Because of the requirement for immediate results, some samples were analysed in Cape Hatt on a Perkin-Elmer 700 Infra-red Spectrometer. This machine is not very stable. After each analysis, a standard was run and the sample absorbance corrected to this standard. The results from this instrument were not considered to be as good as those from the Seakem instrument, so extracts of important samples were taken to Seakem for re-analysis.

The extracts taken to Seakem were analysed on a Perkin-Elmer 337 Infra-red Spectrometer. This instrument has adjustable slits and scan speeds. The resolution and stability of this instrument was far superior to the Perkin-Elmer 700.

Daily calibrations were done using seven standard Lago medio crude solutions in Freon 113. The concentrations of the standards varied from 100 mg/kg to 2000 mg/kg. The corresponding peak heights varied from 12 mm to 102 mm. The standard error of the absorption of the standards over 21 days of analysis was 1 mm at all concentrations. A second order regression curve was determined each day. The sample concentrations were calculated from this curve.

Based on a 15x concentration of dilute extracts, the detection limit is 30 mg/kg, with a precision of 10 mg/kg. At higher concentrations, the precision of the analysis is 1%, based on the precision of the absorption.

4. RESULTS

4.1 SHORELINE TOTAL HYDROCARBON ANALYSES

The results of the shoreline analyses for all three years of the project are given in the following pages. The results are reported to two significant figures only. The validity of the results as a measure of the oil content of a plot or a beach does not depend on the precision of the analyses, but on the consistency of the coverage. This point will be discussed later.

In the following tables the entries tr and 0 refer to extracts with no measurable hydrocarbon but visible colour (tr) and to no measurable hydrocarbon and no colour (0).

4.1.1 1980 SHORELINE COUNTERMEASURE CONTROL PLOTS

Table 1 **High energy shoreline; aged crude Plot H1**

Sample Description	Date	Day	Total hydrocarbon % Surface	Subsurf.
Upper	80-08-23	0	2.0	1.0
Middle	"	0	1.2	1.5
Lower	"	0	7.7	1.2
Plot	"	**0**	**3.6**	**1.2**
Upper	80-08-25	2	0.001	0.056
Middle	"	2	0.019	0.88
Lower	"	2	0.001	0.055
Plot	"	**2**	**0.007**	**0.33**
Upper	80-08-27	4	0.007	0.18
Middle	"	4	0.005	1.62
Lower	"	4	0.016	0.22
Plot	"	**4**	**0.009**	**0.67**
Upper	80-08-31	8	0.037	2.7
Middle	"	8	0.32	0.001
Lower	"	8	0.001	0.26
Plot	"	**8**	**0.12**	**1.0**
Upper	81-07-28	339	0.015	0.15
Middle	"	339	tr	tr
Lower	"	339	-	-
Plot	"	**339**	**.008**	**.008**
Upper	81-08-29	371	tr	0
Middle	"	371	0	0
Lower	"	371	0	0
Plot	"	**371**	**0**	**0**
Upper	82-08-10	717	0	0
Middle	"	717	0	0
Lower	"	717	0	0
Plot	"	**717**	**0**	**0**
Upper	82-09-02	740	0	0
Middle	"	740	0	0
Lower	"	740	0	0
Plot	"	**740**	**0**	**0**

Table 2 **High energy shoreline; emulsion Plot H2**

Sample Description	Date	Day	Total hydrocarbon % Surface	Subsurf.
Upper	80-08-23	0	1.5	2.8
Middle	"	0	0.19	0.13
Lower	"	0	2.3	0.22
Plot	"	**0**	**1.4**	**1.1**
Upper	80-08-25	2	0.001	0.002
Middle	"	2	0.002	0.001
Lower	"	2	0.001	0.001
Plot	"	**2**	**0.001**	**0.001**
Upper	80-08-27	4	0.010	0.011
Middle	"	4	0.001	0.003
Lower	"	4	0.001	0.001
Plot	"	**4**	**0.004**	**0.005**
Upper	80-08-31	8	0.005	0
Middle	"	8	0	0
Lower	"	8	0	0
Plot	"	**8**	**0**	**0**
Upper	81-07-28	339	0	0
Middle	"	339	0	0
Lower	"	339	0	0
Plot	"	**339**	**0**	**0**
Upper	81-08-29	371	0	0
Middle	"	371	0	0
Lower	"	371	0	tr
Plot	"	**371**	**0**	**0**
Upper	82-08-10	717	0	0
Middle	"	717	0	0
Lower	"	717	0	0
Plot	"	**717**	**0**	**0**
Upper	82-09-02	740	0	0
Middle	"	740	0	0
Lower	"	740	0	0
Plot	"	**740**	**0**	**0**

Table 3 **Low energy shoreline; aged crude Plot L1**

Sample Description	Date	Day	Total hydrocarbon %	
			Surface	Subsurf.
Upper	80-08-21	0	0.67	0.88
Middle	"	0	0.87	1.30
Lower	"	0	3.6	2.5
Plot	"	**0**	**1.7**	**1.6**
Upper	80-08-23	2	0.46	0.80
Middle	"	2	0.47	0.009
Lower	"	2	0.61	0.69
Plot	"	**2**	**0.51**	**0.50**
Upper	80-08-25	4	0.45	0.77
Middle	"	4	0.25	0.94
Lower	"	4	0.47	0.47
Plot	"	**4**	**0.39**	**0.72**
Upper	80-08-29	8	0.57	1.26
Middle	"	8	0.77	1.83
Lower	"	8	0.60	1.08
Plot	"	**8**	**0.64**	**1.39**
Upper	81-07-28	341	0.48	0.58
Middle	"	341	0.29	0.75
Lower	"	341	0.65	0.18
Plot	"	**341**	**0.47**	**0.50**
Upper	81-08-29	373	0.25	0.53
Middle	"	373	0.11	0.47
Lower	"	373	0.13	0.45
Plot	"	**373**	**0.16**	**0.48**
Upper	82-08-10	719	0.22	1.57
Middle	"	719	0.18	0.98
Lower	"	719	0.55	0.30
Plot	"	**719**	**0.32**	**0.95**
Upper	82-09-02	742	0.26	0.85
Middle	"	742	1.2	1.3
Lower	"	742	0.044	0.38
Plot	"	**742**	**0.49**	**0.85**

Table 4 **Low energy shoreline; emulsion Plot L2**

Sample Description	Date	Day	Total hydrocarbon %	
			Surface	Subsurf.
Upper	80-08-21	0	0.19	0.050
Middle	"	0	0.45	0.22
Lower	"	0	0.37	-
Plot	"	**0**	**0.34**	**0.13**
Upper	80-08-23	2	0.021	0.011
Middle	"	2	0.034	0.001
Lower	"	2	0.014	0.005
Plot	"	**2**	**0.023**	**0.006**
Upper	80-08-25	4	0.008	0.002
Middle	"	4	0.034	0.001
Lower	"	4	0.006	0.001
Plot	"	**4**	**0.016**	**0.001**
Upper	80-08-29	8	0.037	0.002
Middle	"	8	0.001	0.016
Lower	"	8	0.001	0.005
Plot	"	**8**	**0.013**	**0.008**
Upper	81-07-28	341	0.007	tr
Middle	"	341	0.029	0.013
Lower	"	341	0.005	0.007
Plot	"	**341**	**0.014**	**0.010**
Upper	81-08-29	373	0.017	0.019
Middle	"	373	0.017	0.016
Lower	"	373	0.010	0.013
Plot	"	**373**	**0.015**	**0.016**
Upper	82-08-10	719	0	0
Middle	"	719	0	0
Lower	"	719	0.023	0
Plot	"	**719**	**0.008**	**0**
Upper	82-09-02	742	0	0
Middle	"	742	0.004	0
Lower	"	742	0	0
Plot	"	**742**	**0.001**	**0**

Table 5 **Backshore control; aged crude Plot T1**

Sample Description	Date	Day	Total hydrocarbon %	
			Surface	Subsurf.
Mean	80-08-20	0	4.0	2.3
Mean	80-08-22	2	5.8	3.0
Composite	80-08-24	4	3.4	3.0
Composite	80-08-28	8	6.6	1.7
Composite	81-07-28	342	2.8	2.4
Composite	81-08-29	374	3.4	2.1
Composite	82-08-10	720	2.8	1.6
Composite	82-09-02	743	2.9	1.5

Table 6 **Backshore control; emulsion Plot T2**

Sample Description	Date	Day	Total hydrocarbon %	
			Surface	Subsurf.
Mean	80-08-20	0	1.3	1.5
Mean	80-08-22	2	2.0	2.7
Composite	80-08-24	4	1.3	1.3
Composite	80-08-28	8	6.0	5.8
Composite	81-07-28	342	1.4	2.1
Composite	81-08-29	374	1.6	1.8
Composite	82-08-10	720	1.7	1.7
Composite	82-09-02	743	1.8	1.4

Table 7 **Microbiology control; aged crude Plot TE1**

Sample Description	Date	Day	Total hydrocarbon %	
			Surface	Subsurf.
Composite	80-08-23	0	4.6	2.9
Composite	80-08-25	2	5.0	1.5
Composite	80-08-27	4	5.4	3.3
Composite	80-08-31	8	4.0	4.8
Composite	81-07-28	339	2.9	2.4
Composite	81-08-29	371	2.2	1.9
Composite	82-08-10	717	2.5	4.0
Composite	82-09-02	740	2.4	0.3

Table 8 **Microbiology control; emulsion Plot TE2**

Sample Description	Date	Day	Total hydrocarbon %	
			Surface	Subsurf.
Composite	80-08-23	0	5.1	0.17
Composite	80-08-25	2	10.2	0.46
Composite	80-08-27	4	2.9	6.2
Composite	80-08-31	8	5.8	0.050
Composite	81-08-29	371	2.4	2.6
Composite	82-08-10	717	4.5	2.4
Composite	82-09-02	740	3.6	3.0

4.1.2 1981 SHORELINE COUNTERMEASURE PLOTS

Table 9 **1981 Control; aged crude Plot CC**

Sample Description	Date	Day	Total hydrocarbon %	
			Surface	Subsurf.
Composite	81-08-14	8	1.7	0.15
Composite	81-09-16	41	0.31	0.015
Composite	82-08-10	369	0.030	0.34
Composite	82-09-02	392	0.008	0.022

Table 10 **1981 Control; emulsion Plot CE**

Sample Description	Date	Day	Total hydrocarbon %	
			Surface	Subsurf.
Composite	81-08-14	8	-	0.038
Composite	81-09-16	41	0.093	0.011
Composite	82-08-10	369	0.009	0.039
Composite	82-09-02	392	0.050	0.030

Table 11 **1981 Mixing; aged crude Plot MC**

Sample Description	Date	Day	Total hydrocarbon %	
			Surface	Subsurf.
Pretest Comp.	81-08-06	0	2.1	0.30
Posttest Comp.	81-08-06	0	2.8	1.0
Composite	81-08-14	8	0.50	1.6
Composite	81-09-16	41	1.9	0.19
Composite	82-08-10	369	0.016	0.13
Composite	82-09-02	392	0.014	0.23

Table 12 **1981 Mixing; emulsion Plot ME**

Sample Description	Date	Day	Total hydrocarbon %	
			Surface	Subsurf.
Pretest Comp.	81-08-06	0	1.2	0.11
Posttest Comp.	81-08-06	0	2.1	0.029
Composite	81-08-14	8	1.9	0.031
Composite	81-09-16	41	0.19	0.019
Composite	82-08-10	369	0.023	0.017
Composite	82-09-02	392	0.010	0.045

Table 13 **1981 Exxon dispersant; aged crude Plot D[E]C**

Sample Description	Date	Day	Total hydrocarbon %	
			Surface	Subsurf.
Pretest Comp.	81-08-07	0	2.5	0.03
Posttest Comp.	81-08-07	0	0.61	0.59
Composite	81-08-14	7	0.044	0.24
Composite	81-09-16	40	0.036	0.017
Composite	82-08-10	368	0.008	0.090
Composite	82-09-02	391	0.009	0.005

Table 14 **1981 Exxon dispersant; emulsion Plot D[E]E**

Sample Description	Date	Day	Total hydrocarbon %	
			Surface	Subsurf.
Pretest Comp.	81-08-07	0	2.4	0.015
Posttest Comp.	81-08-07	0	2.0	0.051
Composite	81-08-14	7	0.24	0.029
Composite	81-09-16	40	0.033	tr
Composite	82-08-10	368	0.013	0.017
Composite	82-09-02	391	0.037	0.026

Table 15 **1981 BP dispersant; aged crude Plot D[B]C**

Sample Description	Date	Day	Total hydrocarbon %	
			Surface	Subsurf.
Pretest Comp.	81-08-07	0	0.43	-
Posttest Comp.	81-08-07	0	1.0	0.31
Composite	81-08-15	8	tr	0.32
Composite	81-09-16	40	tr	tr
Composite	82-08-10	368	0	0.003
Composite	82-09-02	391	0	0

Table 16 **1981 BP dispersant; emulsion Plot D[B]E**

Sample Description	Date	Day	Total hydrocarbon %	
			Surface	Subsurf.
Pretest Comp.	81-08-07	0	0.74	0.007
Posttest Comp.	81-08-07	0	0.27	0.44
Composite	81-08-15	8	0.007	0.008
Composite	81-09-16	40	tr	tr
Composite	82-08-10	368	0	0
Composite	82-09-02	391	0	0

4.1.3 1982 SHORELINE COUNTERMEASURE PLOTS

Table 17 **1982 Z-Lagoon Baseline**

Sample	Description	Date	Day	Total hydrocarbon % Surface	Subsurf.
Z1	upper		82-08-10	0	
	middle		"	0	
	lower		"	0	
Z2	upper		82-08-10	0.003	
	middle		"	0	
	lower		"	0.003	
Z3	upper		82-08-10	0	
	middle		"	0	
	lower		"	0	
Z4	upper		82-08-10	0.003	
	middle		"	0.015	
	lower		"	0	
Z5	upper		82-08-10	0	
	middle		"	0	
	lower		"	0	
Z6	upper		82-08-10	0	
	middle		"	0	
	lower		"	0	
Z7	upper		82-08-10	0.003	
	middle		"	0	
	lower		"	0	
Z8	upper		82-08-10	0	
	middle		"	0	
	lower		"	0	
Z9	upper		82-08-10	0	
	middle		"	0	
	lower		"	0	

Table 18 **1982 Control; aged crude Plot ICC**

Sample Description	Date	Day	Total hydrocarbon %	
			Surface	Subsurf.
Oil laying	82-08-12	-1	1.5	
Pretest T6	82-08-13	0	0.15	0.004
Pretest T4	"	0	0.016	0
Pretest T2	"	0	1.1	0.005
Pretest	"	**0**	**0.42**	**0.003**
T6	82-08-20	7	0.52	0
T4	"	7	0.010	0
T3	"	7	0.062	0
T2	"	7	0.69	0
T1	"	7	-	0
Plot	"	**7**	**0.26**	**0**
T6	82-09-15	33	0.21	0
T4	"	33	0.062	0
T3	"	33	0.065	0.042
T2	"	33	0.020	0.005
T1	"	33	0.040	0.005
Plot	"	**33**	**0.080**	**0.01**

Table 19 **1982 Control; emulsion Plot ICE-East**

Sample Description	Date	Day	Total hydrocarbon %	
			Surface	Subsurf.
Oil laying	82-08-12	-1	0.88	
Pretest T6	82-08-13	0	0.63	0.009
Pretest T4	"	0	0.027	0
Pretest T2	"	0	0.17	0
Pretest	"	**0**	**0.28**	**0**
Posttest T6	82-08-14	1	2.4	0.004
Posttest T4	"	1	0.043	0
Posttest T3	"	1	0.97	0.009
Posttest T2	"	1	1.1	0
Posttest	"	**1**	**1.1**	**0.003**
T6	82-08-20	7	1.6	0.003
T4	"	7	0.046	0
T3	"	7	3.4	0.003
T2	"	7	0.12	0
T1	"	7	0.007	0
Plot	"	**7**	**1.0**	**0**
T6	82-09-15	33	1.2	0.027
T4	"	33	0.12	0.009
T3	"	33	1.5	0.018
T2	"	33	0.14	0.019
T1	"	33	0.004	-
Plot	"	**33**	**0.59**	**0.018**

Table 20 **1982 Control; emulsion Plot ICE-West**

Sample Description	Date	Day	Total hydrocarbon %	
			Surface	Subsurf.
Pretest T6	82-08-13	0	0.63	0.009
Pretest T4	"	0	0.027	0
Pretest T2	"	0	0.17	0
Pretest	"	**0**	**0.278**	**0.003**
Posttest T6	82-08-14	1	0.54	0.008
Posttest T4	"	1	0.031	0
Posttest T3	"	1	0.24	0.005
Posttest T2	"	1	0.16	0.003
Posttest	"	**1**	**0.24**	**0.004**
T6	82-08-20	7	0.46	0
T4	"	7	0.026	0
T3	"	7	0.10	0
T2	"	7	0.023	0
T1	"	7	0.005	0
Plot	"	**7**	**0.12**	**0**
T6	82-09-15	33	0.083	0
T4	"	33	0.020	0
T3	"	33	0.053	0
T2	"	33	0.82	0.57
T1	"	33	0.023	0.003
Plot	"	**33**	**0.20**	**0.12**

Table 21 **1982 Exxon dispersant; aged crude Plot ID[E]C**

Sample Description	Date	Day	Total hydrocarbon %	
			Surface	Subsurf.
Oil laying	82-08-12	-1	0.409	
Pretest T6	82-08-13	0	0.44	0.54
Pretest T4	"	0	0.007	0
Pretest T2	"	0	2.1	0.003
Pretest	"	**0**	**0.85**	**0.18**
Posttest T6	82-08-14	1	0.042	0.046
Posttest T4	"	1	0.013	0
Posttest T3	"	1	0.20	0
Posttest T2	"	1	0.88	0
Posttest T1	"	1	0.008	0
Posttest	"	**1**	**0.23**	**0.009**
T6	82-08-20	7	0.012	0
T4	"	7	0.026	0
T3	"	7	0.093	0.005
T2	"	7	0.88	0
T1	"	7	0.008	0
Plot	"	**7**	**0.20**	**0.001**
T6	82-09-15	33	0.003	0
T4	"	33	0.13	0
T3	"	33	0.027	0.25
T2	"	33	0.55	0.13
T1	"	33	0.033	0
Plot	"	**33**	**0.15**	**0.076**

Table 22 **1982 Exxon dispersant; emulsion Plot ID[E]E**

Sample Description	Date	Day	Total hydrocarbon %	
			Surface	Subsurf.
Oil laying	82-08-12	-1	0.49	
Pretest T6	82-08-13	0	0.17	0
Pretest T4	"	0	0.069	0
Pretest T2	"	0	0.21	0
Pretest	"	**0**	**0.15**	**0**
Posttest T6	82-08-14	1	0.15	0
Posttest T4	"	1	0.023	0
Posttest T3	"	1	0.13	0.003
Posttest T2	"	1	0.22	0.010
Posttest	"	**1**	**0.13**	**0.004**
T6	82-08-20	7	0.15	0
T4	"	7	0.053	0
T3	"	7	0.22	0
T2	"	7	1.5	0.010
T1	"	7	0.091	0
Plot	"	**7**	**0.41**	**0.002**
T6	82-09-15	33	0.019	0
T4	"	33	0.12	0.003
T3	"	33	0.038	0.020
T2	"	33	0.15	0
T1	"	33	0.045	0
Plot	"	**33**	**0.075**	**0.004**

Table 23 **1982 BP dispersant; aged crude Plot ID[B]C**

Sample Description	Date	Day	Total hydrocarbon %	
			Surface	Subsurf.
Oil laying	82-08-12	-1	0.88	
Pretest T6	82-08-13	0	0.084	0.005
Pretest T4	"	0	0.29	0
Pretest T2	"	0	0.97	0.037
Pretest	"	**0**	**0.45**	**0.014**
Posttest T6	82-08-14	1	0.83	0
Posttest T4	"	1	0.003	0.71
Posttest T3	"	1	1.9	0.004
Posttest T2	"	1	2.0	0.020
Posttest	"	**1**	**1.2**	**0.18**
T6	82-08-20	7	0.30	0
T4	"	7	0.51	0
T3	"	7	1.1	0.005
T2	"	7	2.8	0.007
T1	"	7	0.11	0
Plot	"	**7**	**0.95**	**0.002**
T6	82-09-15	33	0.017	0.021
T4	"	33	0.32	0.32
T3	"	33	0.17	0.22
T2	"	33	1.2	0.23
T1	"	33	0.032	0.003
Plot	"	**33**	**0.36**	**0.16**

Table 24 **1982 BP dispersant; emulsion Plot ID[B]E**

Sample Description	Date	Day	Total hydrocarbon %	
			Surface	Subsurf.
Oil laying	82-08-12	-1	0.83	
Pretest T6	82-08-13	0	0.73	0.041
Pretest T4	"	0	0.054	0
Pretest T2	"	0	0.52	0
Pretest	"	**0**	**0.44**	**0.013**
Posttest T6	82-08-14	1	2.0	0.005
Posttest T4	"	1	0.90*	0.006
Posttest T3	"	1	3.4	0.003
Posttest T2	"	1	4.1	0.13
Posttest	"	**1**	**3.2**	**0.037**
T6	82-08-20	7	1.2	0
T4	"	7	0.48*	0
T3	"	7	0.63	0
T2	"	7	2.9	0.003
T1	"	7	0.039	0
Plot	"	**7**	**1.2**	**0**
T6	82-09-15	33	0.069	0.026
T4	"	33	0.16*	0.43
T3	"	33	0.18	0.036
T2	"	33	0.69	0.79
T1	"	33	0.053	0.015
Plot	"	**33**	**0.25**	**0.26**

[Values marked * were shown by GC analysis to be primarily gasoline and are not included in the calculations of plot means.]

Table 25 **1982 Backshore; aged crude Plot IMC**

Sample Description	Date	Day	Total hydrocarbon %	
			Surface	Subsurf.
Control berm				
Pretest	82-08-14	0	5.7	0.70
Posttest	82-08-15	1	2.3	-
	82-08-22	7	1.9	2.7
	82-09-15	31	3.1	2.3
Control backbeach				
Pretest	82-08-14	0	4.2	0.027
Posttest	82-08-15	1	1.3	0.84
	82-08-22	7	1.5	0.94
	82-09-15	31	1.8	0.75
Mixed berm				
Pretest	82-08-14	0	10.6	0.22
Posttest	82-08-15	1	6.7	0.14
	82-08-22	7	8.9	0.19
	82-09-15	31	5.7	0.53
Mixed backbeach				
Pretest	82-08-14	0	2.4	0.010
Posttest	82-08-15	1	2.1	0.057
	82-08-22	7	3.8	0.017
	82-09-15	31	3.3	6.52

Table 26 **1982 Backshore; emulsion Plot IME**

Sample Description	Date	Day	Total hydrocarbon %	
			Surface	Subsurf.
Control berm				
Pretest	82-08-14	0	1.7	1.8
Posttest	82-08-15	1	0.93	1.3
	82-08-22	7	1.4	0.77
	82-09-15	31	0.85	1.2
Control backbeach				
Pretest	82-08-14	0	4.2	0.036
Posttest	82-08-15	1	1.2	1.2
	82-08-22	7	2.5	1.5
	82-09-15	31	1.7	1.5
Mixed berm				
Pretest	82-08-14	0	1.2	1.5
Posttest	82-08-15	1	0.77	1.1
	82-08-22	7	0.86	1.2
	82-09-15	31	0.54	1.3
Mixed backbeach				
Pretest	82-08-14	0	1.8	0.014
Posttest	82-08-15	1	3.5	0.012
	82-08-22	7	4.0	0.022
	82-09-15	31	6.5	0.31

4.2 RAGGED CHANNEL BEACHES

Table 27 **Surface oil release, Bay 11 Shoreline**

Sample Description	Date	Day	Total hydrocarbon % Surface	Subsurf.
Posttest	81-08-19			
Upper mean	"	0	2.8	
Middle mean	"	0	1.9	
Lower mean	"	0	0.49	
Posttest mean	"	**0**	**1.7**	
Upper mean	81-08-20	1	0.88	0.026
Middle mean	"	1	0.38	0.009
Lower mean	"	1	0.86	0.015
Mean	"	**1**	**0.71**	**0.017**
Upper mean	81-08-28	8	0.70	0.21
Middle mean	"	8	0.80	0.029
Lower mean	"	8	0.50	0.036
Mean	"	**8**	**0.67**	**0.090**
Upper mean	81-09-15	27	0.71	0.007
Middle mean	"	27	0.68	0.031
Lower mean	"	27	0.38	0.026
Mean	"	**27**	**0.59**	**0.021**
Upper				
Profile 2	82-08-10	356	0.34	0.12
Profile 4	"	356	0.97	0.15
Profile 6	"	356	1.2	0.53
Upper mean	"	356	0.83	0.26
Middle				
Profile 2	"	356	0.40	0.027
Profile 4	"	356	0.27	0.054
Profile 6	"	356	0.22	0.012
Middle mean	"	356	0.30	0.031
Lower				
Profile 2	"	356	0.086	0.006
Profile 4	"	356	0.062	0.016
Profile 6	"	356	0.41	0.016
Lower mean	"	356	0.19	0.013
Mean	"	**356**	**0.44**	**0.10**

Table 28 **Dispersed oil release, Bay 9 Shoreline**

Sample Description	Date	Day	Total hydrocarbon %	
			Surface	Subsurf.
Posttest	81-08-28	1	0.13*	
	82-08-12	349	0**	0**

[* one sample, five others 0]
[** nine samples, all 0]

5. DISCUSSION

The significance of the total hydrocarbon content analyses to the countermeasure experiments and the Ragged Channel experiments are discussed elsewhere (Woodward-Clyde, 1983)

The validity of the analytical results depends not on the precision of the method of analysis, but on the statistical validity of the sampling. In every part of the project the sampling strategy was based on an attempt to determine the hydrocarbon content of the whole plot or beach. The sampling sites within a plot were predetermined to avoid subjectivity and samplers did not deviate from these sites. It was apparent for many of the plots that samples collected by this method, although the best method available, may not adequately describe the plot. The patchy distribution of oil on a plot or beach reduces the confidence of the results. The 1982 sampling, in particular, is biased to high oil coverage, in that the sampling transects were chosen by visual observation of the oil deposited by tide changes.

Over the three years of the project, a very large number of samples have been taken and analysed. The sampling strategies in 1981 and 1982 have been consistent. The validity of these results will be apparent when the overall changes can be compared in succeding years.

6. REFERENCES

Boehm,P.D.,1981, Chemistry:2. Hydrocarbon Chemistry - 1980 Study Results. (BIOS) Baffin Island Oil Spill Working Report 80-2: 184p.

Boehm,P.D.,D.L.Fiest,P. Hirtzer, 1982, Chemistry:2. Analytical Biogeochemistry - 1981 Study Results. (BIOS) Baffin Island Oil Spill working Report 81-2: 354p.

Boehm,P.D., 1983, Chemistry:2. 1983 Study Results. (BIOS) Baffin Island Oil Spill Working Report 82-2: in press

deLappe,B.W.,R.W.Risebrough,A.M.Springer,T.T.Schmidt,J.C.Shropshire, E.F.Letterman,J.R.Payne.1979, The sampling and measurement of hydrocarbons in natural waters. In Hydrocarbons and Halogenated Hydrocarbons in the Aquatic Environment B.K.Afghan, D.McKay, editors, Plenum Press,N.Y.

Dickins,D.F., 1982, Discharge Systems - 1981 Study Results. (BIOS) Baffin Island Oil Spill Working Report 81-9 62p.

Engelhardt,F.R.,R.J.Norstrom, 1982, Petroleum hydrocarbons in two benthic invertabrates, the urchin Strongylocentrotus droebrachiensis and the polychaete Pectinaria granulosa. In Special Studies - 1981 Study Results. (BIOS) Baffin Island Oil Spill Working Report 81-10

Green,D.R., 1981, Chemistry:1. Field Sampling and Environmental Chemistry- 1980 Study Results. (BIOS) Baffin Island Oil Spill Project Working Report 80-1: 93 p.

Green,D.R., B. Humphrey, B.Fowler, 1982, Chemistry:1. Summary of field work- 1981 Study Results. (BIOS) Baffin Island Oil Spill Project Working Report 81-1.

Woodward-Clyde Consultants, 1983, Shoreline Countermeasures - 1982 Study Results. In press.

7. APPENDIX

HYDROCARBON ANALYSIS RESULTS

The results listed in the following pages summarize the results obtained in 1980 and 1981 as they relate to the samples collected in 1982. The samples collected in 1982 are included in the tables, with results where possible. The large number of results pertaining to sample groups which were not collected again in 1982 are not included. Those results may be obtained by referring to the references listed.

The references used in the appendix are:

Number	Reference
[1]	Boehm, 1981
[2]	Boehm et al, 1982
[3]	Boehm, 1983
[4]	Engelhardt, 1982

Table 29 **SEAWATER SAMPLES**

Bay 7 Control

Date	Depth	Analyses	[Oil]	Reference
81-09-03	5m	GC/MS	5µg/L	[2]
81-09-12	5m	GC/MS	3µg/L	[2]
82-08-14	5m	not analysed		[3] 2 samples
82-08-20	5m	not analysed		[3] 2 samples

Bay 9 Dispersed oil release

Date	Depth	Analyses	[Oil]	Reference
80-06-14	1,5,10m	GC/MS	N.D.	[1]
80-08-26	1,5,10m	UV/F	N.D.	[1]
80-09-20	1,5m	UV/F	N.D.	[1]
81-08-27	0-10m	UV/F,GC/MS	1-11,000ug/L	[2] 20 samples
81-08-28	10m	GC/MS	180µg/L	[2]
81-08-29	5m	GC/MS	350µg/L	[2]
81-09-03	5m	GC/MS	8µg/L	[2] mean of 2
81-09-19	5m	GC/MS	1µg/L	[2] mean of 2
82-08-14	5m	not analysed		[3] 2 samples
82-08-28	5m	not analysed		[3] 2 samples

Bay 10 Dispersed oil release

Date	Depth	Analyses	[Oil]	Reference	
80-06-14	1,5,10m	GC/MS	N.D.	[1]	
80-08-26	1,10m	UV/F	N.D.	[1]	
80-08-26	10m	UV/F	86µg/L	[1]	
80-09-19	1,5,10	UV/F	N.D.	[1]	
80-09-19	1,5,5m	GC/MS	N.D.	[1]	
81-08-21	2-4m	UV/F	1µg/L	[2]	
81-08-21	6-8m	UV/F	2µg/L	[2]	
81-08-21	9-10m	UV/F	3µg/L	[2]	
81-08-27	9-10m	GC/MS	100µg/L	[2]	
81-08-28	0-2m	GC/MS	151µg/L	[2]	
81-08-28	3-4m	GC/MS	2820µg/L	[2]	
81-08-28	7-8m	GC/MS	570µg/L	[2]	
81-08-28	9-10m	GC/MS	17µg/L	[2]	
81-08-28	9-10m	GC/MS	340µg/L	[2]	
81-08-29	5m	GC/MS	72µg/L	[2]	mean of 2
81-08-29	9-10m	GC/MS	250µg/L	[2]	
81-09-05	5m	UV/F	16µg/L	[2]	mean of 2
81-09-12	5m	UV/F	11µg/L	[2]	mean of 2
82-08-16	5m	not analysed		[3]	2 samples
82-08-30	5m	not analysed		[3]	2 samples

Bay 11 Surface oil release

Date	Depth	Analyses	[Oil]	Reference	
80-06-14	1,5,10m	GC/MS	N.D.	[1]	
80-08-26	1,5m	UV/F	N.D.	[1]	
80-09-01	1m	GC/MS	N.D.	[1]	
80-09-17	5m	GC/MS	N.D.	[1]	
80-09-19	1,5,10m	UV/F	N.D.	[1]	
81-08-19	0-2m	GC/MS	37µg/L	[2]	mean of 4
81-08-19	3m	GC/MS	5µg/L	[2]	mean of 2
81-08-20	0-2m	GC/MS	370µg/L	[2]	mean of 2
81-08-21	3m	GC/MS	4µg/L	[2]	mean of 2
81-08-22	0-2m	GC/MS	720µg/L	[2]	
81-08-29	5m	GC/MS	62µg/L	[2]	mean of 2
81-09-05	5m	UV/F	29µg/L	[2]	
81-09-12	5m	GC/MS	5µg/L	[2]	mean of 2
82-08-16	5m	not analysed		[3]	2 samples
82-08-22	Surface sheen		535µg/L	[3]	3 samples
82-08-25	0.5m		1.3µg/L	[3]	
82-08-25	Bottom		1.8µg/L	[3]	
82-08-28	Intertidal		1.2µg/L	[3]	
82-08-30	5m	not analysed		[3]	2 samples

Table 30 **LARGE VOLUME WATER SAMPLES**

Bay 7 Control

Date	Depth	[Oil] Filt.	Part.	Reference
81-08-27	2m	1.9µg/L	0.7µg/L	[2]
81-08-29	2m	1.0µg/L	2.2µg/L	[2]
81-09-06	6m	0.2µg/L	0.1µg/L	[2]
82-08-18	10m	0.03µg/L	0.08µg/L	[3]
82-08-25	Bottom	0.01µg/L	0.01µg/L	[3]

Bay 9 Dispersed oil release

Date	Depth	[Oil] Filt.	Part.	Reference
81-08-13	5m	0.2µg/L	0.2µg/L	[2]
81-08-29	2m	22µg/L	0.8µg/L	[2]
81-08-31	6m	18µg/L	1.8µg/L	[2]
81-09-02	6m	2.5µg/L	0.7µg/L	[2]
81-09-05	6m	0.7µg/L	0.3µg/L	[2]
82-08-18	10m	0.01µg/L	0.02µg/L	[3]
82-08-25	Bottom	0.01µg/L	0.02µg/L	[3]

Bay 10 Dispersed oil release

Date	Depth	[Oil] Filt.	Part.	Reference
80-09-07	1m	4ng/L*	2ng/L*	[1]
81-08-14	5m	0.2µg/L	0.1µg/L	[2]
81-08-18	5m	0.2µg/L	0.05µg/L	[2]
81-08-23	3m	0.2µg/L	0.05µg/L	[2]
81-08-28	4m	30µg/L	4.6µg/L	[2]
81-08-30	6m	21µg/L	2.9µg/L	[2]
81-09-04	6m	0.2µg/L	0.1µg/L	[2]
82-08-18	10m	0.01µg/L	0.04µg/L	[3]
82-08-25	Bottom	0.03µg/L	0.03µg/L	[3]

Bay 11 Surface oil release

Date	Depth	[Oil] Filt.	Part.	Reference
80-09-11	8m	2ng/L*	1ng/L*	[1]
81-08-12	4m	0.5µg/L	0.2µg/L	[2]
81-08-19	3m	5.9µg/L	0.005µg/L	[2]
81-08-20	1m	10.2µg/L	0.5µg/L	[2]
81-08-21	1m	2.0µg/L	0.05µg/L	[2]
81-08-22	1m	3.5µg/L	0.3µg/L	[2]
81-08-22	6m	0.6µg/L	4.7µg/L	[2]
81-08-24	6m	0.9µg/L	0.2µg/L	[2]
81-08-25	1m	2.2µg/L	0.6µg/L	[2]
81-08-25	6m	0.9µg/L	0.4µg/L	[2]
81-09-06	6m	1.3µg/L	0.05µg/L	[2]
82-08-17	0.5m	0.02µg/L	0.06µg/L	[3]
82-08-17	10m	0.01µg/L	0.09µg/L	[3]
82-08-21	Intertidal	0.01µg/L	1.1µg/L	[3]
82-08-25	Bottom	0.01µg/L	0.01µg/L	[3]
82-08-25	0.5m	0.01µg/L	0.03µg/L	[3]
82-08-25	Intertidal	0.29µg/L	0.04µg/L	[3]

* These samples were analysed by fractionation and subsequent GC analysis. The results can not be directly compared to the other listings.

Table 31 **TISSUE PLOT SEDIMENTS**

Bay 7 Control

Date	[Oil] 3m	[Oil] 7m	Reference
81-08-17	0.36µg/g	0.43µg/g	[2]
81-08-31	0.34µg/g	0.67µg/g	[2]
81-09-10	0.45µg/g	1.1µg/g	[2]
82-08-18	-	1.3µg/g	[3]

Bay 9 Dispersed oil release

Date	Depth	[Oil]	Reference
80-06-	18m	0.6µg/g	0-4cm [1]
80-06-	18m	2.6µg/g	10-15cm [1]
80-06-	18m	1.3µg/g	28-33cm [1]

Date	[Oil] 3m	[Oil] 7m	Reference
81-08-10	0.34µg/g	0.38µg/g	[2]
81-08-28	3.1µg/g	2.1µg/g	[2]
81-09-13	0.45µg/g	9.0µg/g	[2]
82-08-17	-	2.5µg/g	[3]

Bay 10 Dispersed oil release

Date	Depth	[Oil]	Reference
80-06-	12m	0.8µg/g	[1]
80-06	5m	N.D.	[1]

Date	[Oil] 3m	[Oil] 7m	Reference
81-08-14	0.45µg/g	0.49µg/g	[2]
81-08-29	1.40µg/g	0.88µg/g	[2]
81-09-11	0.73µg/g	1.7 µg/g	[2]
82-08-16	-	1.7 µg/g	[3]

Bay 11 Surface oil release

Date	[Oil] 3m	[Oil] 7m	Reference
81-08-12	0.22µg/g	0.55µg/g	[2]
81-08-21	0.16µg/g	0.18µg/g	[2]
81-09-08	0.70µg/g	1.1 µg/g	[2]
82-08-15	10.3µg/g	9.5µg/g	[3]

Table 32 **BENTHIC PLOT SEDIMENTS**

Bay 7 Control

Date	[Oil] 3m	[Oil] 7m	Reference
81-09-10	0.80µg/g	1.2µg/g	[2]
82-08-18	-	-	[3]

Bay 9 Dispersed oil release

Date	[Oil] 3m	[Oil] 7m	Reference
81-09-10	2.7µg/g	3.8µg/g	[2]
82-08-17	0.8µg/g	-	[3]

Bay 10 Dispersed oil release

Date	[Oil] 3m	[Oil] 7m	Reference
81-09-11	0.99µg/g	1.6µg/g	[2]
82-08-16	0.77µg/g	-	[3]

Bay 11 Surface oil release

Date	[Oil] 3m	[Oil] 7m	Reference
81-09-08	0.90µg/g	3.8µg/g	[2]
82-08-15	7.0µg/g	5.3µg/g	[3]

[Deep Sediments: 82-09-10 2 samples, detection limit oil [3]]

Table 33 **FLOC SAMPLES**

Bay 7 Control

Date	[Oil] 3m	7m	Reference
81-08-17	-	-	[2]
81-08-31	0.066µg	0.12µg	[2]
81-09-10	0.040µg	0.024µg	[2]
82-08-18			[3]

Bay 9 Dispersed oil release

Date	[Oil] 3m	7m	Reference
81-08-10	0.035µg	0.040µg	[2]
81-08-28	4.26µg	9.70µg	[2]
81-09-13	0.10µg	0.10µg	[2]
82-08-17			[3]

Bay 10 Dispersed oil release

Date	[Oil] 3m	7m	Reference
81-08-14	0.10µg	0.19µg	[2]
81-08-29	0.071µg	4.0µg	[2]
81-09-11	0.050µg	0.068µg	[2]
82-08-16			[3]

Bay 11 Surface oil release

Date	[Oil] 3m	7m	Reference
81-08-12	0.084µg	0.96µg	[2]
81-08-21	-	0.23µg	[2]
81-09-08	0.071µg	0.11µg	[2]
82-08-15	0.61µg	0.23µg	[3]

Table 34 **SEDIMENT TRAPS**

Bay 7 Control

Date in	Days in	Depth	Total Extract.	TotalHC	Reference
81-08-27	7	3m	410µg	45µg	[2]
81-08-27	7	7m	400µg	35µg	[2]
81-09-05	7	7m	590µg	<5µg	[2]
81-09-15	335	10m		DL	[3]

Bay 9 Dispersed oil release

Date in	Days in	Depth	Total Extract.	TotalHC	Reference
81-08-13		10m	350µg	<5µg	[2]
81-08-27	3	3m	1000µg	310µg	[2]
81-08-27	3	7m	190µg	70µg	[2]
81-08-27	3	7m	1320µg	150µg	[2]
81-09-01	3	3m	1770µg	50µg	[2]
81-09-01	3	3m	80µg	<5µg	[2]
81-09-01	3	7m	550µg	90µg	[2]
81-09-05	7	3m	700µg	5µg	[2]
81-09-05	7	7m	580µg	80µg	[2]
81-09-15	335	10m		DL	[3]

Bay 10 Dispersed oil release

Date in	Days in	Depth	Total Extract.	TotalHC	Reference
81-08-14		10m	400µg	<5µg	[2]
81-08-27	3	3m	300µg	35µg	[2]
81-08-27	3	7m	380µg	170µg	[2]
81-08-30	3	3m	530µg	40µg	[2]
81-08-30	3	7m	160µg	30µg	[2]
81-09-05	7	3m	520µg	<5µg	[2]
81-09-05	7	7m	770µg	20µg	[2]
81-09-15	335	10m			[3]

Bay 11 Surface oil release

Date in	Days in	Depth	Total Extract.	TotalHC	Reference
81-08-18	3	3m	190µg	25µg	[2]
81-08-18	3	3m	180µg	15µg	[2]
81-08-23	3	3m	340µg	25µg	[2]
81-08-23	3	3m	240µg	35µg	[2]
81-09-15	335	10m		DL	[3]
82-08-11	14	7m	Different		[3]
82-08-11	14	7m	methods used		[3]
82-08-25	8	7m		"	[3]
82-08-25	8	7m		"	[3]

In 1982, some airlifting occurred in the areas the traps were deployed.

Table 35 **TISSUE SAMPLES**

Astarte borealis

Bay 7 Control

Date	Depth	[Oil]	Reference
81-08-17	7m	22µg/g	[2]
81-09-01	7m	51µg/g	[2]
81-09-11	7m	56µg/g	[2]
82-08-18	7m	6.8µg/g	[3]

Bay 9 Dispersed oil release

Date	Depth	[Oil]	Reference
81-08-08	7m	0.81µg/g	[2]
81-08-28	7m	463µg/g	[2]
81-09-11	7m	171µg/g	[2]
82-08-17	7m	19.0µg/g	[3]

Bay 10 Dispersed oil release

Date	Depth	[Oil]	Reference
81-08-14	7m	0.43µg/g	[2]
81-09-01	7m	364µg/g	[2]
81-09-12	7m	310µg/g	[2]
82-08-16	7m	25.0µg/g	[3]

Bay 11 Surface oil release

Date	Depth	[Oil]	Reference
81-08-13	7m	0.47µg/g	[2]
81-08-25	7m	2.7µg/g	[2]
81-09-11	7m	140µg/g	[2]
82-08-15	7m	37.0µg/g	[3]

Mya truncata

Bay 7 Control

Date	Depth	[Oil]	Reference
81-08-17	7m	0.34µg/g	[2]
81-08-31	7m	114µg/g	[2]
81-09-11	7m	47µg/g	[2]
82-08-18	7m	0.41µg/g	[3]

Bay 9 Dispersed oil release

Date	Depth	[Oil]	Reference
81-08-07	3m	0.40µg/g	[2]
81-08-07	7m	0.35µg/g	[2]
81-08-28	3m	215µg/g	[2]
81-08-28	7m	121µg/g	[2]
81-09-10	3m	135µg/g	[2]
81-09-10	7m	114µg/g	[2]
82-08-17	7m	0.81µg/g	[3]

Bay 10 Dispersed oil release

Date	Depth	[Oil]	Reference
81-08-14	3m	0.78µg/g	[2]
81-08-14	7m	0.57µg/g	[2]
81-08-29	3m	368µg.g	[2]
81-08-29	7m	277µg/g	[2]
81-09-11	3m	131µg/g	[2]
81-09-11	7m	157µg/g	[2]
82-08-16	7m	0.96µg/g	[3]

Bay 11 Surface oil release

Date	Depth	[Oil]	Reference
81-08-12	7m	0.43µg/g	[2]
81-08-21	7m	2.0µg/g	[2]
81-09-08	7m	93µg/g	[2]
82-08-15	7m	1.3µg/g	[3]
82-09-12	7m	4.7µg/g	[3]

Macoma calcarea

Bay 7 Control

Date	Depth	[Oil]	Reference
81-08-17	7m	1.0µg/g	[2]
81-09-01	7m	82.1µg/g	[2]
81-09-11	7m	85.5µg/g	[2]
82-08-18	7m	1.9µg/g	[3]

Bay 9 Dispersed oil release

Date	Depth	[Oil]	Reference
81-08-08	7m	0.73µg/g	[2]
81-08-28	7m	74.9µg/g	[2]
81-09-11	7m	836µg/g	[2]
82-08-17	7m	25µg/g	[3]

Bay 10 Dispersed oil release

Date	Depth	[Oil]	Reference
81-08-14	7m	2.1µg/g	[2]
81-09-01	7m	406µg/g	[2]
81-09-12	7m	440µg/g	[2]
82-08-16	7m	14µg/g	[3]

Bay 11 Surface oil release

Date	Depth	[Oil]	Reference
81-08-13	7m	2.5µg/g	[2]
81-08-25	7m	24.5µg/g	[2]
81-09-11	7m	246µg/g	[2]
82-08-15	7m	60µg/g	[3]

Serripes groenlandicus

Bay 7 Control

Date	Depth	[Oil]	Reference
81-08-17	7m	1.2µg/g	[2]
81-09-01	7m	517µg/g	[2]
81-09-11	7m	73µg/g	[2]
82-08-18	7m	5.2µg/g	[3]

Bay 9 Dispersed oil release

Date	Depth	[Oil]	Reference	
81-08-08	7m	0.68µg/g	[2]	
81-08-28	7m	482µg/g	[2]	
81-08-28	7m	186µg/g	[2]	Hand picked
81-09-10	3m	160µg/g	[2]	Hand picked
81-09-10	7m	116µg/g	[2]	
81-09-10	7m	97µg/g	[2]	Hand picked
82-08-17	7m	5.2µg/g	[3]	

Bay 10 Dispersed oil release

Date	Depth	[Oil]	Reference	
81-08-14	7m	1.4µg/g	[2]	
81-08-29	3m	698µg/g	[2]	Hand picked
81-08-29	7m	278µg/g	[2]	
81-08-29	7m	329µg/g	[2]	Hand picked
81-09-11	7m	149µg/g	[2]	
81-09-11	7m	141µg/g	[2]	Hand picked
82-08-16	7m	3.0µg/g	[3]	

Bay 11 Surface oil release

Date	Depth	[Oil]	Reference
81-08-13	7m	-	[2]
81-08-21	7m	6.0µg/g	[2]
81-09-11	7m	394µg/g	[2]
82-08-15	7m	13µg/g	[3]

Strongylocentrotus droebachiensis

Bay 7 Control

Date	Depth	[Oil]	Reference
81-08-17	7m	12.8µg/g	[4]
81-08-31	7m	47.2µg/g	[4]
81-09-11	7m	43.7µg/g	[4]
82-08-18	7m	4.6µg/g	[3]

Bay 9 Dispersed oil release

Date	Depth	[Oil]	Reference
81-08-07	7m	16.5µg/g	[4]
81-08-28	7m	45.9µg/g	[4]
81-09-10	7m	237.1µg/g	[4]
82-08-17	7m	46.0µg/g	[3]

Bay 10 Dispersed oil release

Date	Depth	[Oil]	Reference
81-08-14	7m	24.9µg/g	[4]
81-08-29	7m	91.7µg/g	[4]
81-09-11	7m	111.2µg/g	[4]
82-08-16	7m	20.0µg/g	[3]

Bay 11 Surface oil release

Date	Depth	[Oil]	Reference
81-08-12	7m	12.6µg/g	[3]
81-08-21	7m	78.0µg/g	[3]
81-09-08	7m	430.0µg/g	[3]
82-05-	7m	180.0µg/g	[3]
82-08-15	7m	46.0µg/g	[3]
82-09-	7m	67.0µg/g	[3]

NOTE: the averages from reference 4 are arithmetic means, those from reference 3 are geometric means.